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Engineering News-Record

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Raising Pennsylvania's Allegheny River Bridge Under Traffic

Under War Department orders, Pennsylvania's double-deck bridge at Pittsburgh, a 7800-ton steel structure, carrying a remarkably dense traffic, has been raised 13 feet to provide greater navigation clearance. The ingeniously planned jacking operations, detailed in this issue, continued for six months, at no time interfering with railroad traffic. To prevent distortion, constant check on the levels of the ends was maintained by the aid of a water-leveling device.

May 1, 1919

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"The Paving that's Saving"

KREOLITE LUG WOOD BLOCKS

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ENGINEERING NEWS-RECORD

A WEEKLY JOURNAL
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AND CONTRACTING

E. J. MEHREN, *Editor* — CHARLES WHITING BAKER, *Consulting Editor*

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Foresight as a Dividend-Paying Asset

AN investment of a hundred million in ships before the war, said Homer L. Ferguson before the Foreign Trade convention in Chicago last week, would have saved a billion dollars during the war. In other words, a stitch in time would have saved nine, a fact which the nation until recently declined to recognize in the matter of merchant marine and naval auxiliaries. Mr. Ferguson's remark goes beyond ships, however. Foresight is needed in all activities, and nowhere more than in technical industry. During the past two years those producers who had improved their plant and equipment for high efficiency and were ready for the highest demands as to capacity and speed of production formed the backbone of the home army, and incidentally earned the dividends of success. Similarly, the men who today are preparing for the future will constitute our industrial strength in the new era.

Opposing Reports on New York Garbage Disposal

THE muddled garbage-disposal situation in New York City would not be cleared a bit if equal value were to be given to the directly opposing recommendations of the Merchants' Association, which advises incineration, and the Brooklyn Chamber of Commerce, which pronounces for reduction. But the two reports are not of equal value. The Merchants' Association report reads as if written before the war, in accordance with preconceived notions that "cremation" is the only sanitary means of garbage disposal. Cost data are purposely avoided. The Chamber of Commerce report takes into account the importance of waste conservation by grease and fertilizer recovery, and presents cost estimates for both systems of disposal. Both reports—but very differently—show the need for a thoroughgoing engineering study of the whole problem of garbage collection and disposal for the five boroughs of New York City. As we have previously urged, here is work for the engineering societies. They may not be called upon to make the needed studies, but they should never rest until they have used every reasonable effort to see that the studies are made.

What Is a Building Material?

STATISTICS are dangerous things. Once they are established their source is forgotten, and the user may do with them what he wills. Offhand, it looks as though some such end may come to the figures on building-material prices collected by the United States Department of Labor and published in the pamphlet entitled "A Comparison of Prices During the Civil War and Present War." Every day quotations from this investigation bob up in unexpected places, proving many and various things. Whether the theories so expounded are valid or not, those who study them should know that the "building materials" on which this exhaustive study were based are eighteen, and their names are alphabetically arranged: Brick, cement, chestnut lumber, flaxseed, furniture, hemlock, lime, linseed oil, oxide of zinc, pine boards, pine in log, putty, spruce, tar, turpentine, tubs, window glass, wooden pails. The necessity for finding materials with available prices during two widely separated wars may have restricted the investigators, but why masquerade such a collection under the heading "Building Materials"?

An Achievement in Bridge Raising

AN achievement which probably represents the solution of a greater number of field problems than ever before confronted an erection engineer is the raising of the Pennsylvania R.R. bridge over the Allegheny River a maximum distance of 13 ft., described on another page of this issue. This operation involved the jacking up of the double-deck main spans, designed for six railroad tracks, the heaviest for their length in the country, without interference with the dense traffic in and out of the Pennsylvania station, and was carried out under a strict time limit in less than five months for the actual raising of the main spans. The great number and special arrangement of jacks necessary—the four lines of trusses were raised on the intermediate piers without shifting the jacks—and the difficulties in obtaining a sufficient number of adequate capacity; the necessity for working on these intermediate piers in restricted space limits, requiring the design of jacking girders to support the ends of two trusses in each line without encroaching on train-clearance lines, the design of grillage units which could be easily handled and installed from the hanging platforms below the main trusses; the application of a well-known hydraulic principle in a simple device for indicating the relative level of the ends of the trusses being raised on a given intermediate pier, kept at the same level to prevent twisting of portal bracing and end floor-beam connections; the design of spliced extensions for the columns in the approach viaduct, and the scheme for placing precast concrete blocks in building up the piers of these approaches—all introduced complications and difficulties which required unusual ingenuity in their solution. That the whole series of operations should have been carried out so successfully within the one-year time limit allowed by the Government is a real tribute to the engineers in charge.

Training Operators of Construction Machinery

HOW to obtain competent operators of construction machinery will be a burning question when the prospective construction program is started, for the supply of such men is always limited. It is not uncommon for a contractor to find himself faced with a shutdown because he lacks a man able to handle a road roller, concrete mixer, trenching machine or piledriver. His only recourse is to select some promising man from among the laborers and assign him to the task, with the foreman to give him such instruction as opportunity permits. This means likelihood of delaying or even spoiling a part of the work and of causing excessive maintenance and repair expense on the machinery while the man is acquiring proficiency. How can this condition be remedied and the supply of machine operators increased? The short courses in highway construction held by many Western state universities, during the winter, appear to offer a logical means for training such men. It is generally easy to get a few competent operators as instructors at that time, before the construction season opens. A method which has been tried at the Nebraska State University, in view of the shortage of men to operate construction machinery on road work, consisted in organizing a special short course very similar to that already established for the instruction of tractor operators for agricultural machinery. A three-week course of lectures and demonstrations should suffice to turn out men able to handle machinery efficiently and economically. Men thus trained are not to be classed as common laborers, and probably many of them would develop into foremen or superintendents.

Full Facts on the Engineering Standards Movement

OPEN discussion of plans and purposes is a first essential in a matter that concerns future engineering and industrial development so intimately as the Engineering Standards movement. The thought of every engineer on the subject is needed. But hitherto there has been no possibility of such thought and discussion, because those in charge of the planning failed to take the engineering public into their confidence. Dr. E. B. Rosa's elaborate statement of the case in this issue supplies a substratum of fact on which the reader may build his thought. Obviously, discussion must be based on information concerning such matters as form of organization, intersociety relations, field to be occupied, control and financing.

Relying on broad support for its ultimate success, the Engineering Standards movement is in its very nature one that peculiarly demands widest publicity; even more so at the present point of proposed reorganization on surprisingly broad lines. The statement which we publish is founded on this very thought, that the soundest results will follow if all engineers will consider the subject with close attention, on the basis of the facts.

Were any proof needed of the desirability of an open statement of the situation, it might be found in the fact that some of the men most closely concerned with the movement, men responsible for the direction of large societies in connection with it, are misinformed as to essential phases of the committee activities. Without breach of confidence it may be said that comments on the editorial discussions of the standards movement printed in these columns Apr. 10 and 17 have made this quite evident. Therefore, if misconception prevails in circles that should be fully informed, it is idle to expect that engineers the country over can form useful opinions concerning the movement.

We bespeak for Dr. Rosa's statement close and interested study. It describes the plan which is now before the directing boards of the societies—though the divisional feature of the organization is for the present only Dr. Rosa's personal idea of what should develop. The Engineering Standards movement concerns all engineers and all who are engaged in industrial technology. Few developments of such broad importance have come before the profession in years.

The central feature of the reorganization soon to be decided upon is the inclusion of safety-code work with work on standards of shape and quality of materials. But accompanying this very important change is that of improvement in organization. The aim now is to make the Engineering Standards Committee a broadly representative institution, which in its present make-up it is not and could not be. If the movement as a whole is to be constituted by the free and enthusiastic coöperation of numerous societies, only a broadly democratic constitution can bring success.

There are many phases of the remarkable organization and system set forth that invite comment; and there is not a little that might be questioned or traversed. The data of the psychological problem with which the noted physicist deals in this instance seem to call for scrutiny. Perhaps the method of deduction also may be worth examination. But it is precisely these elements of the statement that must be considered in full by the court of engineering opinion. In harmony with Dr. Rosa's clearly expressed thought, the widest range of study and reflection upon the subject will best promote the right outcome.

With respect to one point, however, the author's statement needs to be put in clearer light at once, for the point is fundamental to many considerations of the subject. Dr. Rosa disclaims all technical action or judgment on the part of the Engineering Standards Committee. He says that the committee "will approve a standard . . . not because the committee has itself examined it and passed an independent judgment upon it, which that committee will not attempt to do." This goes to the heart of the question of how conflicting interests in the formulation of a standard are to be harmonized. What will develop in those cases where duplication, or conflict of authority, or unharmonized difference of technical opinion, occurs? It is held by many advocates of the standards organization that duplication and conflict now occur to a harmful degree, and that they would be eliminated by the proposed system. And these same men, like Dr. Rosa, hold that the committee will accomplish this object without entering into technical questions.

Such views need to be tested by the proof of actual fact. They should be applied, for example, to the question of possible protests against the A. S. M. E. boiler-code work, to the controversy over motor-car axles, to the conflict in the field of specifications for cast-iron water pipe, to the situation in which steel-rail specifications are involved, and to the difficulties of some years ago in the matter of the cement specifications. In

such cases as these—as also in others that may readily arise; for example, if a standardization of I-beam sections should be undertaken—there are unavoidable technical differences which no mere overhead pacificatory direction could level. They include differences between societies, differences between producer and user, and differences between producers, or between users, but technical differences in all cases. Only technical methods can successfully settle such differences, and for this reason reassuring advance disclaimer of all technical action by the Standards Committee is likely to be belied by subsequent developments.

A Clarion Call to the Profession

LAST week's meeting in Chicago, at which delegates from 74 societies gathered to consider the advisability of pushing the formation of a Federal Department of Public Works, marked a distinct step forward in engineering-society activity in this country. What is more, it sounded a clarion call to the profession: Can engineers, architects, chemists and their co-workers in construction activities get together with an effectiveness equal to the task of carrying through a great national project?

If the spirit of last week's conference is consulted, the answer is clearly and emphatically, Yes. Could there be a more competent body to give that answer? Here were representatives of every type of society, the great nationals, the locals from coast to coast, and architects', chemists' and contractors' organizations. There was such unanimity, such confidence, that repeatedly Philip N. Moore, sitting as chairman at the really pivotal session, pleaded that if anyone saw insuperable obstacles to the movement or lacked faith in it that he come forward and express himself. But there were no objectors.

That the task is not an easy one was fully realized. The delegates went home fully appreciative of that to which the conference had set its hand, but confident not merely that the result would be accomplished but that through the doing of the task the profession would be bound together as never before. The inevitableness of that secondary result is obvious. An effective organization alone can win in this project—and that organization can be made permanent, the agency for doing thereafter the many things that have long awaited the hand of a national organization of engineers.

Fortunately, the project is one on which it is easy to unite. No selfish, no local, no partisan interest is served. The public good alone is the issue—and it recommends itself no less to other patriotic citizens than to engineers, architects, chemists and their allied workers. Therein, in fact, lies the solid reason for its success—that the public at large can be won to its support.

The project is now in hand. There is no turning back. Success alone can be the end of the endeavor.

Mr. Channing, chairman of Engineering Council, said at the dinner that nothing had given him such hope for ultimate professional unity as the proceedings of the conference. In so saying he echoed, we are sure, the views of everyone present. We take it that Mr. Channing's hopes were founded chiefly on the unanimous opinion regarding the need for a centralizing agency and on the very evident spirit of give and take that prevailed. But there were other hopeful indications—a grasp of political problems (which surely will stimulate united action), an understanding of methods of promotion and organization, and a determination that engineers shall no longer be hesitant in promoting their group interests. The agitation of the five years just passed is bringing results. Crystallization is apparent. The day of professional unity is not far off.

What form the organization that will unite the profession eventually will take cannot now be foretold. Certain it is that the first step will be federation. Repeatedly, plans have been proposed for a single engineering society, all-embracing, extending its scope to civic activities as well as to technical and scientific development. Those proposals have had but small response. Eventually we may find the mechanism for such a development, but the time is not now. At the conference the sentiment plainly was in favor of federation—and federation under Engineering Council.

As to Engineering Council, its opportunity to become the medium of unifying the profession has been immensely advanced through this conference. In fact, if we read the sentiment aright, it was that the council was the logical agent of unity. The attitude of its members was so broadminded, their appreciation of the problems of all classes of engineers so evident, that the council won friends for itself even among those most critical of it in the past and most doubtful of its ability, because of its genesis and constitution, to represent the profession broadly. The last objection seemed to be removed when Mr. Channing told of the pending amendment to the rules which would permit the admission of local societies.

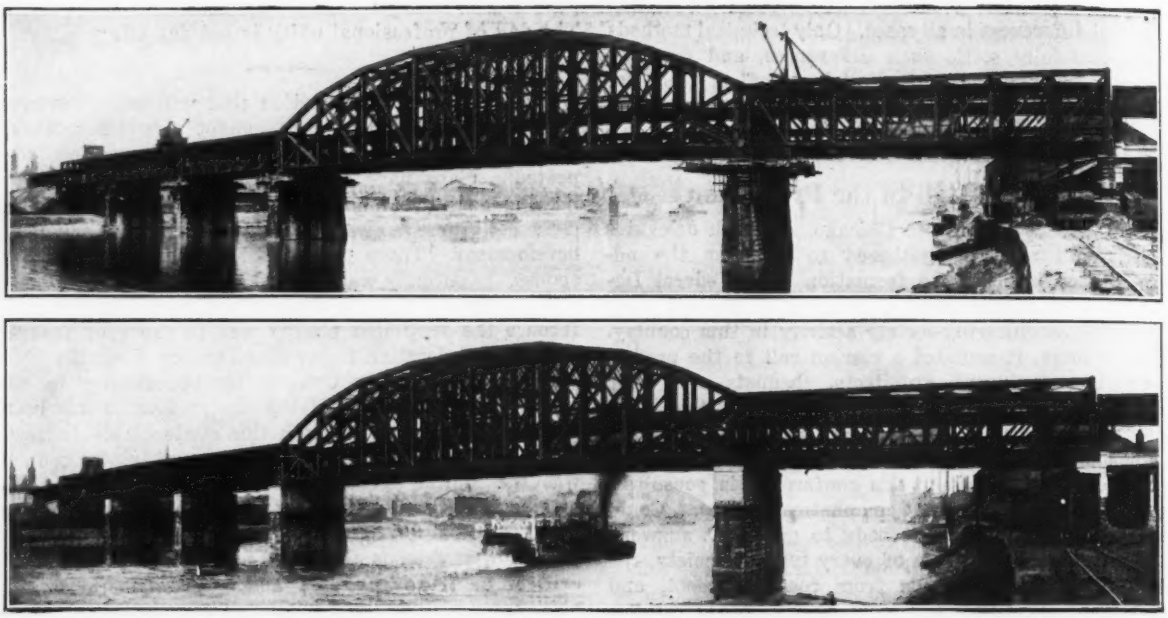
Not a little of the favorable impression made by the council was due to its broadminded handling of the conference. It called the conference, made it possible, but of its own volition elected to have no part therein. In other words, where it might easily have dominated, it freely stepped aside, declaring its object to be merely that of affording a forum where the societies could reach their own decisions. Upon the announcement by Mr. Channing that council members as such would have no voice in the proceedings, the conference at once accorded to them and to the members of the National Service Committee the privilege of the floor.

Finally, a word should be said as to the effectiveness of the arrangements for and the machinery of the conference. They were a tribute to the organizing ability of those in charge. The tentative program, adopted quickly by the conference, showed full appreciation of the probably necessary steps of the procedure, but was unhesitatingly changed in detail to suit the needs as the conference developed. The conduct of the chair was effective and tended to expedition. The Western Society of Engineers supplied not only the meeting place but plentiful stenographic and clerical assistance. The technical societies of Chicago, through their General Committee, took care of the housing of the delegates and gave a dinner to the entire conference.

It was a big piece of work effectively handled. It will linger long in the pleasant recollections of those who attended, and will go down in the annals of the profession as one of its most important meetings.

Raising Allegheny River Bridge 13 Feet By Jacking

Without Interruption of Traffic Underclearance of Four-Track Two-Level Steel Structure at Pittsburgh Is Increased 12.6 Feet



DOUBLE-DECK STEEL SPANS LIFTED BODILY TO INCREASE CLEARANCE BY 12.6 FEET—PROGRESS PHOTOGRAPH AND FINAL APPEARANCE

ONE of the most original engineering accomplishments ever carried to successful completion is the lifting of about 7800 tons of steel bridge truss spans and 7150 tons of approach viaducts a maximum distance of 13½ ft. with absolutely no interruption of the heaviest railroad traffic. On Mar. 23, 1917, the War Department ordered that the Pittsburgh, Fort Wayne & Chicago Railroad bridge over the Allegheny River at Pittsburgh, Penn., consisting of five main river spans of four-truss, double-deck type and their approaches, be raised from a clearance line at El. 738 to a revised line at El. 750.6, and fixed the time limit for completion at one year from date. It was required that the lifting operation should be carried out between trains and proceed consecutively from pier to pier to prevent excessive grades. All the truss spans on any one pier were raised simultaneously by the use of hydraulic jacks of 100-, 200- or 500-ton capacity. The actual operations of lifting these spans, which were designed for six tracks and are the heaviest for their length in the country, were carried out in less than five months.

Restricted space and side-clearance limitations complicated the problem of placing new steel grillages on the main piers and providing support for the jacking girders. Furthermore, the approach girder spans and steel bents also had to be raised and the piers supporting these bents rebuilt by the addition of precast concrete blocks. In the Pittsburgh approach where the side clearances were limited, spliced column extensions were added to the base of the steel column to give the necessary height. A simple device was installed to indicate whether the various spans at one pier were being kept at the same level during the raising operation.

After the completion of the raising, Mar. 15, 1918, much other work had to be done on the bridge, such as the replacing of corroded angles in the upper level struts of the bracing and the placing of cast-iron protection plates above the lower-level tracks, and the introduction of diagonal longitudinal bracing in the approach viaducts on both ends of the bridge.

This bridge was erected in 1902, and a general description of the structure will be found in *Engineering News* of Nov. 20, 1902, p. 417.

General Requirements—The Government order required a clear height 12.6 ft. greater than that furnished by the original structure. This involved the raising of the grade of the lower-level tracks at the ends of the longest span a distance of 12.47 ft. and 13.44 ft., respectively, the latter being the maximum lift required in the structure. The various lifts at the end and intermediate piers are given in the accompanying table, which also indicates the jacking loads at the piers, the length of spans and the dead weight of the spans.

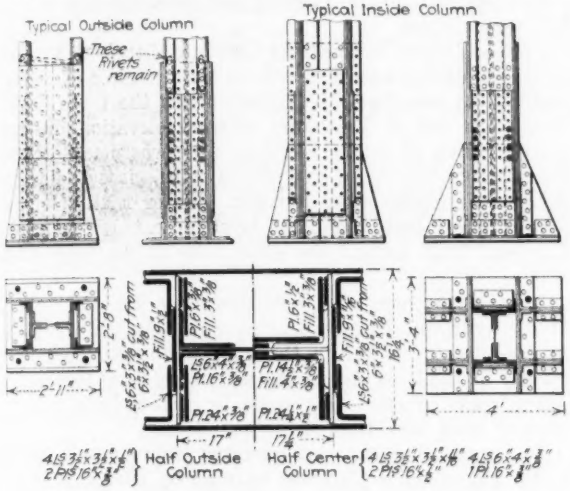
The total length raised was 3283 ft., which was divided into five operations, as follows: (1) Five main river spans supported by six piers, total length 987 ft.; each span is composed of four trusses of double-deck of pin-connected type on a skew, designed for three tracks

MAIN TRUSS SPANS AND WEIGHTS—DISTANCES RAISED

Pier or Span No.	Span Center to Center of Piers, Feet	Dead Weight of Span, Tons	Total Jacking Load at Pier, Tons	Distance Raised, Feet
1	165.5	1199	602	10.47
2	337.5	3459	2331	12.47
3	160.9	1057	2258	13.44
4	160.9	1048	1048	13.19
5	160.5	1052	1048	12.53
6	.....	....	528	11.26
Total.....		7815	7815	

on each deck, although only two tracks on each deck have been placed; (2) Pittsburgh approach viaduct of 25 half-through plate-girder spans supported on steel column bents, the total length being 823 ft., weight 4000 tons; (3) The Duquesne Way viaduct, 24 spans of which were raised, covering a total length of 1230 ft., weight 2350 tons. This is a double-track-deck plate-girder viaduct supported on steel columns; (4) Allegheny approach viaduct, composed of five half-through plate-girder spans, double track, on steel columns, length 177 ft., weight 800 tons; and (5) Penn Avenue bridge, which is a three-span half-through plate-girder bridge 60 ft. long, with steel columns at intermediate points.

In planning the operation noninterference with traffic was the most important point to be considered, so that all lifting equipment had to be designed to insure the most rapid lifting operations possible. No attempt was made to lift any part of the superstructure under live load. All of the superstructure resting upon any given pier had to be lifted at the same time and kept level during the operation, the distance lifted being limited by the

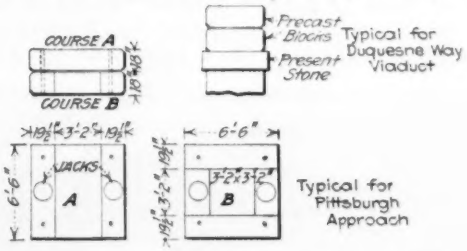


TWO TYPES OF DETAILS OF TYPICAL SPLICES FOR COLUMN EXTENSIONS

fact that no grade exceeding 1% was to be permitted during the progress of the work. In order to prevent undue strain of the riveted connections in the viaduct approaches, it was planned to raise the girders in consecutive sections of three spans, each lift to be limited to two or three inches.

As the interval between trains was seldom more than 15 min., a complete telephone system connecting the train dispatcher's office with those points in the field where the work was being carried on was installed. An elaborate chart was prepared to show when the track was required, how long, and when it would be released. During the work it was found necessary to allow 1.5% grade at various stages, and the final maximum grade is 1.28% on the Pittsburgh approach. The grade of the upper-level tracks was modified so that they were not lifted the same amount as the lower-level tracks, the difference being made up in depth of ties, some ties as deep as 20 in. being required.

History of the Operations—The work was let on a percentage basis, and as many new requirements were discovered the added work extended the time of the final completion of the contract nearly one year longer than that required to raise the bridge to its new level. Preliminary work on the approaches was started June 7, 1917, and all extra work on the main spans and approaches was completed Mar. 15, 1919. The lifting of the main spans and the Allegheny approaches began



PRECAST BLOCKS IN APPROACH PIERS

Oct. 30, 1917, and the last lift was completed Mar. 15, 1918, the contract date limit being Mar. 23. The average lift on the main piers was 3 in. at first, increasing to about 6 in. per day, the maximum, accomplished Feb. 25, 1919, being one foot three inches.

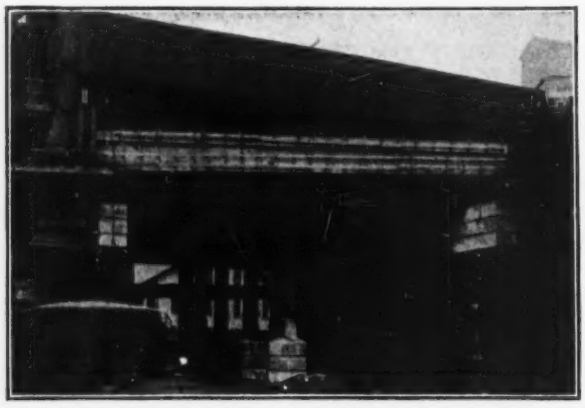
Work on the Pittsburgh approach began Aug. 11, 1917, and was finished Mar. 11, 1918, the work being carried on simultaneously throughout the structure with a force that averaged about 75 men. The addition of splice material and reinforcement for corroded struts and floor-beams, the installation of new longitudinal bracing, and other additional work, kept the contractor on the work for another year.

Approach Columns Raised—The first work was the enlargement of the concrete piers supporting the columns of the approach bents to give sufficient width to support the jacks. As seen in one of the photographs, built-up steel brackets were bolted on two sides of the columns to support the dead weight. Beneath these the jacks were placed, the capacity of these jacks varying from 40 to 80 tons. For the heavier brackets eight 1¼-in. bolts were used at the lower end to take the tension, and wood blocks were inserted between the column angles at the top to take the compression.

The first operation was the placing of wood blocks for supporting the jacks, or, in case the precast blocks were finished, outside units were used under the jacks, as indicated by one of the drawings. The jacking up proceeded in 2-in. increments, using timber blocking under the column bases until the structure had been raised about 2 ft., when the center precast block under the column base was inserted. The second tier of these blocks consisted of five units, as indicated on the drawing, the outside oblong blocks running in the opposite direction to those of the first tier. In placing this second tier, the first units placed were those under the jacks, the latter then being used to raise the column by means of brackets in 3-in. lifts, using timber blocking until the column was high enough for the insertion of the center section under the column base. The outside sections could then be placed and the work proceed in similar order tier by tier.

On account of insufficient lateral clearance for trains on the track under the viaduct, the concrete blocks on the Pittsburgh approach were brought up only to the level of the new ground line. The additional height necessary was provided by steel column extensions spliced to the old columns, as indicated on one of the drawings herewith showing the two general types—the inside column with central diaphragm, and an outside column of four angles and two web plates only,

using new center diaphragms at the splices. In placing the new column extension, the dead and the live loads were supported by timber struts from the ground to the girders, one on each side of the column, each composed of three 12 x 12-in. timbers resting on timber cribbing drift-bolted to fit. After thus supporting the superstructure, the old column bases were removed by



PRECAST CONCRETE BLOCKS FOR PIERS AND ABUTMENTS AT PENN AVENUE

cutting out the rivets, new holes were drilled, the column extensions were inserted, and the splice material was added.

As the original structure was constructed with a level grade, the introduction of the grades on the approaches made it necessary to add new longitudinal bracing between columns in certain bays. On the Pittsburgh approach this bracing was introduced in five bays at various parts of the structure, always being placed in a fixed span. Double diagonals were used in all cases except in the end bay, where a special detail was necessary to connect to the abutment because of the presence of an electric-wire conduit running along the abutment. Details of this concrete-covered steel-beam construction to span the conduit and connect to the abutment are indicated in one of the accompanying drawings. In the other approaches, single diagonals with a subdiagonal and vertical at the center to shorten the unsupported length of the strut were used, thus decreasing the number of points of connection between the new diagonals and the columns.

Jacking Up Main Trusses—The eight truss bearings at each intermediate pier were lifted at the same time, keeping all trusses at the same elevation in order to prevent undue strain on the rigidly connected floor-beams and portal bracing. The scheme finally adopted to allow rapid and continuous jacking operations is indicated by the diagram herewith. The problem was to design the jacking girders and steel grillage units to avoid interference and to keep outside of the train-clearance line. New steel brackets were bolted to the vertical end posts of the main trusses, below which the 500-ton hydraulic jacks could be placed upon jacking girders. These girders were carried by jacking columns built up of I-beams and placed in openings left in the grillage units.

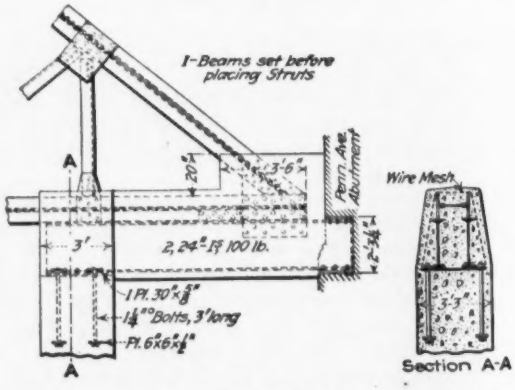
It was first necessary to raise the railroad track 8 in. to increase the clearance. The ends of the old I-beam grillages were burned off in order to allow the outside units of I-beams filled with concrete to be placed. These outside units, which had to carry the complete dead load on the jacks, were built up of I-beams bolted together before the concrete filling was placed.

The posts and jacking girders were then erected and the old truss grillages were bolted to the shoes, and jacking proceeded, using 3-in. timber blocking under the old grillages until the trusses were high enough for the insertion of the central unit of the first tier of new grillage. As the 500-ton jacks only had an 8-in. stroke, the clearance between the jacking girders and the truss shoes only permitted an 8-in. raise, and it was necessary to raise these jacking girders every time the bridge was raised 8 in. The dead load of the jacks, jacking girders and supports was about six tons, hence a set of auxiliary jacks was installed to raise the jacking girders by brackets, as indicated on the sketch, to allow rail grillages to be slipped under the jacking columns. These rail grillages were later replaced by I-beam stools. All of these operations, of course, had to be carried on simultaneously at each of the four truss points on a given pier. After the operations had become familiar, it was possible to carry through one complete cycle for a 4-in. raise and place the 3-in. plank in four minutes.

Special Device Insured the Constant Level—A simple hydraulic device was designed, on the principle of water seeking its own level, to indicate when the truss bearings were not at the same relative elevation during the operation of lifting. A ¾-in. pipe was placed below the floor of the span, and risers with glass indicator tubes were placed at each truss. Water with coloring matter was inserted, and the level indicated by placing a rubber band around the glass tube at the beginning of the lift.

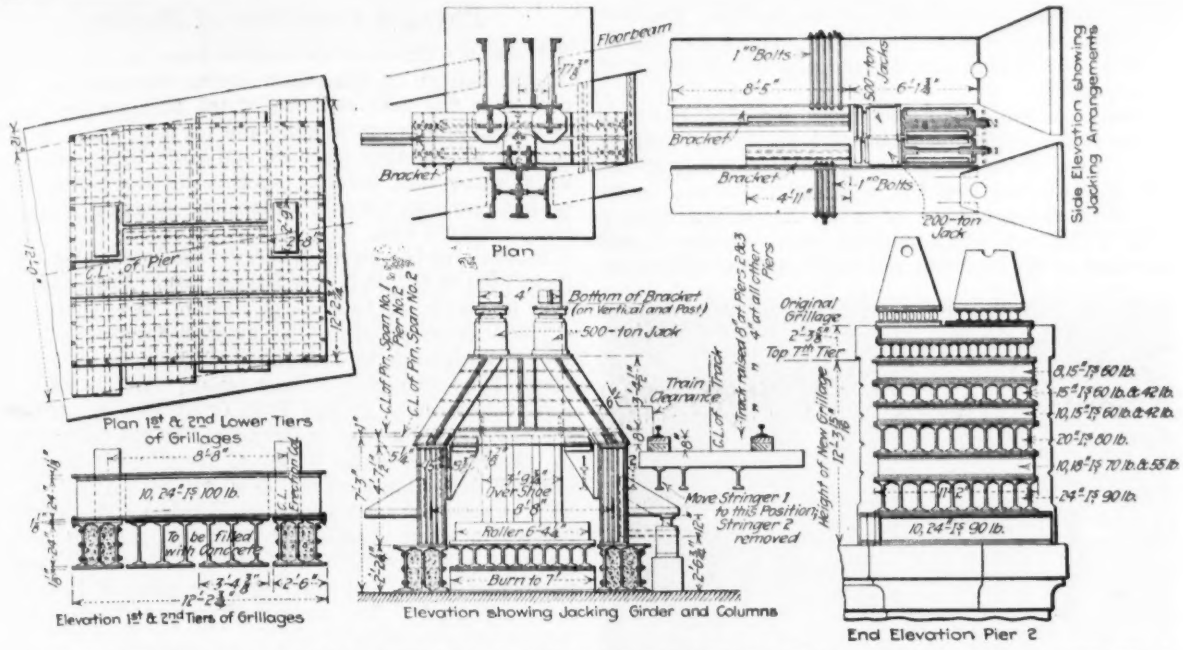
All that the men who were operating the inlet valves of the hydraulic jacks had to do was to watch carefully to see that the water in the glass tube was kept constantly at the level shown by the rubber-band indicator. After some practice this could be successfully accomplished with less than ½-in. variation.

The hydraulic jacks were operated from a single steam pump placed on a platform carried by cantilever supports on the north side of span No. 2. The main line



SPECIAL LONGITUDINAL BRACING ANCHORAGE AT ABUTMENT

of 1½-in. pipe extended the full length of the five bridge spans and connected to 1-in. pipes running parallel to each pier, to which copper pipe was attached and connected through the supply valve with each jack on the various piers. These valves were operated by capstans above the floor of the bridge, as indicated in one of the photographs. Stop valves were placed on each side



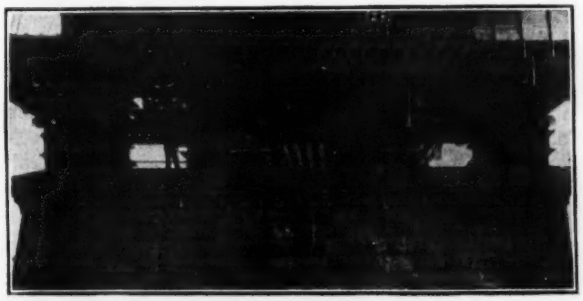
JACKING GIRDERS AND COLUMNS WITH I-BEAM GRILLAGES SATISFY CLEARANCE REQUIREMENTS—PIER NO. 2

of the connection between the pump and the longitudinal 1½-in. pipe, also just beyond each pier, in order to govern the flow of the water to any set of jacks on any pier desired. A discharge valve was also placed at the connection for the copper supply pipe for each set of jacks, allowing the mixture of water and 50% alcohol used in the winter to be saved by catching it in buckets and returning to the pump.

Placing Steel Grillages—Timber platforms were hung from the trusses on each side of the main piers at a level just high enough to allow the steel grillages to be rolled into place on pipe rollers. Platforms on both sides of the pier were required because grillage units of alternate tiers had to be made double, each half being placed from opposite sides of the pier to allow space for the jacking columns. In order to avoid delay in obtaining material it was found necessary to use I-beams for these grillages from whatever source was available. For example, 15-in. I-beams from the old Louisville bridge were obtained and many other beams were furnished by the railroad. The height of the last tier was fixed by the required total lift at the given pier. These grillage units were fabricated at the site, using as cover plates the old Quebec bridge hangers which had been utilized in lifting the suspended span. These were 1⅛ in. thick for those from the old span which was lost in the river, and 1¼ in. thick for the hangers last used.

The mortar beds between the grillage tiers made up about 4½ in. of the varying difference between the net height of the steel and the height of the concrete encasement forming new caps for the piers. The concrete encasement was carried up to the top of the seventh tier; the concrete was placed by first filling the I-beam grillages with 1:3:6 gravel concrete, then placing the heart, 10½ ft. wide between the grillages, of the same mix. The outside width of 13 ft. was then made up by 1:2:4 mix, using gravel screened to ¾ in. and working the mortar against the forms so that no stone would show after the base was rubbed.

Vertical joints were made to prevent the development of cracks in the concrete at the corner of the steel grillages where it joined the large mass of heart concrete, by using a steel plate nailed to the forms in a narrow V shape, this plate being removed with the forms and the opening pointed up after the concrete had set. The horizontal construction joints were made at any coursing joint, the latter being formed by triangular nailing strips spaced about 2 ft. 2½ in. apart vertically. The care used in the location of the construction joints has resulted in the fact that no crack whatever has appeared, although several months have elapsed since the work was completed.



GRILLAGE BEAMS IN PLACE UNDER THE FOUR MAIN TRUSSES AT PIER NO. 4

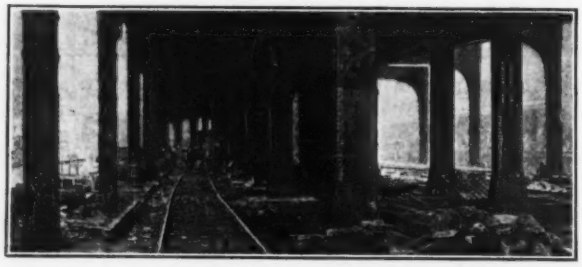
Repairing Corroded Struts and Floor-Beams—The locomotive gases and blast were found to have caused very severe loss in section of the transverse struts and floor-beams on the upper level above the floor tracks. It was therefore found necessary to replace the 4 x 4-in. angles of the struts by splicing in new sections in both flanges, usually 3 to 4 ft. long, and spliced by 3½ x 3½ x $\frac{7}{16}$-in. angles. In some cases plates 10¾ x ¾ in., about 5 ft. long, were riveted to the lower strut angles. Cast-iron protection plates to prevent future corrosion were bolted to the bottom of these struts in the upper

deck throughout the length of the bridge. The corroded floor-beams were rebuilt by adding web plates to both sides of the old webs and reinforcing the lower flange angles.

The work was performed under the general supervision of J. C. Bland, engineer of bridges, Pennsylvania Lines West of Pittsburgh, and was carried out by the Seaboard Construction Co., Philadelphia, Penn., under the personal supervision of S. P. Mitchell, president, with H. S. Goodloe as superintendent in charge of field operations. W. W. Priest, assistant engineer of bridges,

JACKS ON JACKING GIRDERS—INDICATOR TUBE AND VALVE CONTROLS

Pennsylvania Lines West, was in immediate charge of all field work. The grillages and other steel work were fabricated at the site by the Seaboard Construction Co., and bracing, column extensions, miscellaneous steelwork, etc., were furnished by the McClintic-Marshall Co. and the Fort Pitt Bridge Works, both of Pittsburgh. The estimate of the cost (made April, 1917)



NEW BASES SPLICED TO VIADUCT COLUMNS
Jacking brackets are seen on far columns to the right

was $500,000, but owing to the increase in the costs of all kinds of labor and material during the progress of the work, and loss in efficiency due to the unusually severe cold of the winter of 1917-18, the final cost was from $750,000 to $800,000. The exact cost is not known, as accounts are not yet closed.

Physical Properties of Marbles

ELABORATE tests on marbles were carried out by the Bureau of Standards during the past year to determine the relative value of the different available types and grades for building and for other uses. They covered 52 different marbles, and dealt with strength, water absorption, porosity, specific gravity, loss on repeated freezing, thermal expansion, electrical conductivity, and the like.

In compressive strength (dry) the marbles ranged from 7850 to 50,205 lb. per square inch. After immersion in water for two weeks most of them showed a slightly lower strength, the greatest loss being over 25%. Resistance to freezing and thawing, as determined from 30 cycles, showed equally variable results. But some samples showed little or no loss, and a few actually showed a gain in strength. To put the matter to the test of a longer series of freezing-and-thawing cycles, a device has been set up which will automatically shift a specimen back and forth between a cold chamber and a warm chamber at fixed intervals. By this means it will be possible to expose a specimen to a large number of cycles, and determine the effect of freezing more accurately. The same machine is to be used for testing other building stone.

The heat expansion of marble exhibited a varying rate even at ordinary temperatures, so that a single coefficient cannot be given. More important, however, is the fact that after expansion under heat the marble did not return to its original dimensions after cooling, part of the increase of size being permanent; and successive heatings showed a continuous effect; that is, a progressive increase of dimension.

Measurement of electrical resistivity of different marbles showed a large range of values, so that marble for electrical uses must be specially selected.

Rough Faces Do Not Strengthen Glue Joints

Comparative strength tests of glued joints made with smooth and tooth-planed contact surfaces at the Forest Products Laboratory of the United States Forest Service at Madison, Wis., last year showed that there is no advantage in roughening the faces. It has been commonly believed among woodworkers that scratched or tooth-planed surfaces make a stronger glued joint than smoothly planed faces, but the tests distinctly disprove this belief. Pairs of hard maple blocks were used as the test specimens. They were glued together with a high-grade hide glue, allowed to stand for a week, and then sheared apart in a testing machine. Eleven sets of tests, each test comprising four joints of the smooth and four of the tooth-planed type, gave practically identical average strengths for the two types. In seven of the eleven sets the smooth joints showed the higher strength; the average of all the smooth joints was 2040 lb. per square inch, and that of the tooth-planed joints 1988 lb. per square inch. The area of wood on the fracture surface was counted in every case; the average wood face percentage for the smooth joints was 47 and that for the roughened-face joints 45, which would indicate if anything a greater glue strength for the smooth-face joint. With respect to strength, the 11 tests gave quite consistent results. The figures for the smooth-face joints (each figure an average of four test-pieces) ranged from 943 to 3086 lb. per square inch, those for the roughened-face joints from 1366 to 2409.

Engineering Societies Organize to Push Public Works Department Bill

Seventy-Four Societies Represented at Conference in Chicago—Principles Adopted With Reference to Character of Proposed Department

REPRESENTATIVES of seventy-four engineering societies, having a combined membership of over 100,000, met in Chicago last week and as a result of discussions occupying two full days formed an organization to promote the passage by Congress of a bill creating a Federal Department of Public Works. Principles were adopted for determining the character of the proposed department, and specific recommendations were made as to the services and bureaus to be incorporated therein. The drafting of the bill itself was left to a committee with full power, and the management of the organization to an executive committee, which was authorized to appoint a finance committee to which, in turn, will be left the problem of raising the necessary funds. A campaign committee was also authorized, and, in part, appointed.

Sessions were also devoted to a consideration of Government coördination in mapping the United States and to the relations of nonmember organizations to Engineering Council. Reports of these sessions will be found in the news section of this issue.

A dinner was given to the delegates by the General Committee of the Technical Societies of Chicago, F. K. Copeland, chairman, while the Western Society of Engineers placed its meeting hall, with stenographic and other facilities, at the disposal of the conference.

The Conference

J. Parke Channing, as chairman of Engineering Council, whose National Service Committee called the conference, set forth in a brief introductory speech, reprinted in full on an adjoining page, the purpose of the conference and the general reasons why engineers had repeatedly urged the formation of a Federal Department of Public Works. He made it clear that Engineering Council desired, in connection with the conference, to afford only the means of bringing the delegates together, and that it had no desire to be a determining factor in the conclusions reached. For that reason, Engineering Council, and its members who happened to be present, would have no voice in the proceedings.

Thereupon, upon a call for nominations, M. O. Leighton, chairman of the National Service Committee, was elected chairman of the conference, and E. S. Nethercut, secretary of the Western Society of Engineers, was elected secretary. It was unanimously voted that the members of Engineering Council and the National Service Committee, who were present but did not hold delegates' credentials, receive the privileges of the floor, without, however, the right to vote. The chair was authorized to appoint committees on resolutions, text of bill, Government engineering activities, and credentials.

Upon completion of the organization details the designated work of the conference was taken in hand, the initial step being the presentation by Philip N. Moore, of St. Louis, of the report of the National Service Committee on the project for a Department of Public Works. The report will be found in full on an adjoining page. The burden of it was that the public good demanded the coördination of the engineering activities of the Government, and that this demand was so fundamental that sooner or later it was sure to be complied with. It would be better, he contended, that engineers should be instrumental in bringing about the necessary coördination than that it should be left to others.

Principles Governing Constitution of Proposed Department

From the outset it was apparent that the delegates were unanimous in the belief that a Department of Public Works should be formed, and all of the speakers addressed themselves rather to the principles to govern its formation than to the question of the advisability of its creation. Almost the first question raised was as to the amount of engineering work included within the activities of a given service or bureau necessary to make it eligible for inclusion in the proposed department. It was apparent that the general sentiment was in favor of including only those services and bureaus whose work is *chiefly* of an engineering character. There was some sentiment in favor of the proposal to separate the engineering functions from bureaus which had acquired engineering activities which are, plainly, not essentially connected with their main work, such as the supervision of hydro-electric licenses on the public lands by the Forest Service. Eventually the sentiment prevailed that services and bureaus should be transferred *in toto*, and that those having primarily a function other than engineering should at the outset be left where they are now rather than be transferred to the new department. W. D. Blair, representing the American Institute of Architects, stated that the architects favored the formation of a department with broad scope, which should cover all construction work, including the design and erection of buildings. Speaking for the American Chemical Society, Julius Stieglitz declared that the chemists desire that the chemical bureaus of the Government should be transferred to the proposed department. He pointed out that chemistry was not engineering, but that the alliance of the two was such that the chemical bureaus properly belonged in a department of public works.

The ideas and principles thus developed in the discussion were referred to the resolutions committee, which brought in the following report covering the subject:

"This conference of the delegates from engineering and related organizations respectfully recommends to the public and to Congress that legislation be enacted covering the following principles:

"1. That the services and bureaus of the national Government having to do chiefly with matters of engineering and architecture be grouped in one department to be known as the Department of Public Works.

"2. That the Department of Public Works comprise those works which are built and operated for the use of the public.

"3. That the Department of Public Works be made available when desirable for the performance of special engineering and architectural work for the use of other Government bureaus.

"4. That there be a systematic classification and organization of engineers, architects and other employees, whose status shall be such that they may be recruited and maintained on merit."

These resolutions were discussed very fully, the chief discussion centering about the drawing of a distinction between military and nonmilitary work. The sentiment was plain that the delegates believed that only nonmilitary work should be handled by the proposed department, and the question revolved merely about the desirability of including the terms "military" and "nonmilitary" in the statement of principles. The resolutions committee explained that the second principle, as it had been drafted, was intended to exclude military works, because they obviously are not built and operated for the use of the public, and after full discussion the conference decided that this was a full and sufficient distinction. In the discussion, it was also pointed out that the heads of practically all Government services and bureaus having to deal chiefly with engineering work had already been approached with reference to the proposal to form the department and that no opposition had developed.

Services and Bureaus To Be Included

Following the adoption of the statement of principles, discussion was taken up in committee of the whole as to the specific services and bureaus which should be included in the proposed department. The purpose of this discussion, and any action that might be taken, was not to bind the conference, but to serve as information for the benefit of the committee on Government engineering activities, which was directed to bring in at a later session a report on details regarding the formation of the department.

By constant reference to the principles reported above, the conference rather quickly decided the disposition of the various bureaus and activities having engineering functions. The results of the votes are shown in the accompanying table.

Rather full discussion took place with reference to the disposition of the Public Health Service, the Construction Division of the Army, the Forest Service and the Bureau of Standards. The Public Health Service was eliminated because its duties were considered not to be chiefly engineering, while the Construction Division of the Army was included because its work was plainly that ordinarily performed by civilian rather than by military engineers.

The Forest Service was included chiefly because of its important engineering function of supervision over water-power development on the public lands, and also because of the large mileage of roads which it builds. The proposal was considered to recommend the splitting of the work, the silviculture and the strictly agricultural features remaining where they now are, and the engineering features being transferred to the new department. On motion, however, the view prevailed that the whole service should be transferred.

Final decision that the Bureau of Standards would best be in the new department was reached on representation by a number of the delegates of the important engineering functions of the bureau. The Panama Canal was not to be included because its work now is that of maintenance rather than of engineering design and construction.

It was also decided that it would be best to advocate the changing of one of the existing departments into a Department of Public Works rather than to work for the creation of a new department, making a new cabinet position. A motion also prevailed that no changes be made in the personnel, organization and methods of operation of the various bureaus, but that they be taken over into the proposed department just as they now are.

A motion to include in the proposed department a bureau whose purpose would be to promote by means of publicity the construction industries of the country, similar to the promotional and educational work that the Department of Agriculture does for agriculture, was lost.

BUREAUS TO BE INCLUDED IN PROPOSED PUBLIC WORKS DEPARTMENT AS DETERMINED IN COMMITTEE OF THE WHOLE

("Yes" means that it should be included; "No" that it be excluded)

Department of the Treasury	
Public Health Service	No
Supervising Architect	Yes
Department of War	
Public Buildings and Grounds	No
Construction Division of the Army	Yes
Rivers and Harbors	Yes
Mississippi River Commission	Yes
California Débris Commission	Yes
Department of the Interior	
General Land Office	Yes
Indian Affairs	No
Geological Survey	Yes
Reclamation Service	Yes
Bureau of Mines	Yes
National Park Service	Yes
Alaska Engineering Commission	Yes
Department of Agriculture	
Forest Service	Yes
Weather Bureau	No
Public Roads	Yes
Department of Commerce	
Bureau of Standards	Yes
Bureau of Lighthouses	No
Coast and Geodetic Survey	Yes
Unattached Functions	
The Panama Canal	No

(*N. B.*—Some of these decisions were reversed by vote on report of committee on Government activities, which see.)

Report of Committee on Government Engineering Activities

Basing its conclusions upon the discussion which had taken place in the committee of the whole and upon the statement of principles which had been adopted, the committee on Government engineering activities on the following morning presented the following report which, with minor amendment (said amendments being incorporated in the report as printed below) was adopted. The report, as adopted, is as follows:

Your committee charged with a consideration of the question which Government activities should be coördinated in a national Department of Public Works recommends:

1. That the establishment of a national department of public works should be accomplished by grouping those Government bureaus, services, commissions and other activities whose functions are predominantly of an engineering or architectural character in what is now the Department of the Interior, and thereafter designating that department the Department of Public Works.

2. That the transfer of any bureau, service or commission from any other department to a Department of Public Works should be accomplished without change of personnel, compensation and general plan or organization, leaving the coördination of the several activities, the simplification of organization and the establishment of additional bureaus—such, for example, as a bureau of chemical engineering—to be effected as the need for the same may from time to time become apparent.

3. That in transferring river and harbor work and other work nonmilitary in character, but now in charge of the Engineer Corps of the United States Army, to a Department of Public Works, the relation of the Army engineer to such work be not changed, and that there should be no relinquishment of nonmilitary duty by the Army engineers now on such duty until transfer of these engineers to military duty can be made without detriment to the public interests.

Your committee finds that among the bureaus, services and activities which logically belong in a Department of Public Works are the following:

A Bureau of Public Roads.

The United States Reclamation Service.

The Alaska Engineering Commission.

The Construction Division of the United States Army.

A Bureau of River, Harbor and Canal Work, including such functions as are now exercised by the Mississippi River Commission and the California Débris Commission.

A Bureau of Architecture.

A Bureau of Surveys, including the Coast and Geodetic Survey.

A Bureau of Mines.

The Geological Survey.

The Forest Service—at least until the same is divorced from the supervision of water-powers and road building.

The Bureau of Standards.

Your committee believes it would be unwise to determine at this time to what extent the proposed department of public works should control the engineering activities of the General Land Office, of the National Park Service, of the Bureau of Lighthouses, of the Bureau of Indian Affairs, and of the Public Health Service and of various commissions, such as commissions on buildings and grounds, and therefore suggests that such matters may well be deferred for consideration to a later date, preferably until the department has been organized.

Permanent Machinery for Pushing Bill

Much time was given to the discussion of the permanent machinery that should be established in order to promote the passage of the proposed bill. There was general appreciation of the necessity for organizing the profession down to the last Congressional district, in order that the merits of the proposed measure might be brought home to members of Congress through the public and through engineers resident in each Congressional district. The lack of national organization of the profession was brought up repeatedly and much deplored, the discussion at times broadening out to include suggestions for the coördination of all elements of the profession. J. Parke Channing, chairman of Engineering Council, pointed out that the council was still in its formative stage, and so far had included only national engineering societies. An amendment was pending, however, which, if adopted, would permit the affiliation of local societies as well. He was of the opinion that engineers might learn from the American Federation of Labor, which is very loose in its organization and admits all bodies that can contribute to its ends—not merely the craft unions, but the industrial unions as well. In fact, the headquarters organization of the federation has the power to organize unions on its own initiative, without having them subordinate to state organizations or to general craft unions. This permits all classes of labor organizations to come in under the coördinating influence of one body. Concluding, he offered the services of the National Service Committee to the conference in its work of promoting the Public Works Department bill. This offer was promptly accepted, with hearty thanks, by the conference.

With reference to methods of promoting the bill, W. H. Hoyt, of Duluth, maintained that there was need for a journal devoted to the public and civic interests of engineers. Mr. Channing agreed with Mr. Hoyt on the need for such a paper, pointed out that it had been considered by Engineering Council but that the council could do nothing in the matter for lack of funds. E. J. Mehren, on behalf of the McGraw-Hill Co., Inc., offered to the conference space in the journals controlled by that company in the promotion of the bill, as much space as necessary being allocated weekly to the committee. A similar offer was immediately made by the *American Architect*, and similar offers were received at later sessions from the *Railway Age* and from the International Trade Press, Inc., the latter controlling a number of papers.

On the question of financing the campaign, J. L. Harrington, of Kansas City, proposed that an appeal be made to all local engineering societies to pledge an appropriation of $1 per year per member for this work. Philip N. Moore of St. Louis, on the other hand, believed that the financing could and should be done by the four national engineering societies, and urged that to that end the members of those bodies impress upon their directors the importance of the Public Works Department movement, and the advisability of appropriating the necessary funds. Leonard Metcalf, of Boston, pointed out the condition of the treasuries of some of the national societies, and recited how necessary activities had been curtailed because of the shortage of funds. He felt, therefore, that the funds should be raised by an appeal to the profession generally, rather than by asking the national societies alone to shoulder the burden.

As the result of the discussion on organization and financing, a resolution was presented by F. A. Vaughn, of Milwaukee, providing that the conference be made permanent and that the object be the promotion of this bill. The resolution was referred to the resolutions committee and was finally adopted by the conference in the following form:

"Resolved, that this conference be known as the Engineers', Architects' and Constructors' Conference on National Public Works, that it continue in existence until dissolved by its own action, and that its officers and committees be empowered to further the organization and development of a national department of public works."

Three Committees Appointed

Upon motion by Frederic H. Fay and Leonard Metcalf, the conference adopted as its machinery of permanent organization the following three committees: (1) An executive committee, which was empowered to appoint a finance committee and also to add to the other committees to be authorized; (2) a committee on text of bill; (3) a campaign committee.

A committee to determine the personnel of these three committees was then authorized, and after recess brought in the names reported at the close of this report, making it clear, however, that in the time available there was not opportunity to canvass the situation thoroughly by geographical districts and by branches of the profession, and that the personnel committee expected that the executive committee would fill the necessary gaps by enlarging the campaign committee, particularly.

The method of financing the work of the organization was left entirely in the hands of the finance committee.

The advisability of the conference's indorsing the formation of the proposed Department of Transportation was discussed, and while many views favorable to such indorsement were expressed, two successive resolutions introduced thereon by the resolutions committee were tabled, and no action was taken.

At the concluding session resolutions were adopted thanking the Western Society of Engineers and the General Committee of Technical Societies of Chicago for their hospitality and for the facilities they had provided for the handling of the details of the conference. The thanks of the conference were also extended to the McGraw-Hill Co., Inc., the *American Architect*, the *Railway Age*, and the International Trade Press, Inc., for the offer of magazine space to the conference in its work of promoting the passage of the proposed bill.

The following committee appointments, reported by the personnel committee, were approved:

Executive Committee: M. O. Leighton, Washington, D. C., chairman; Francis H. Blossom, D. A. Garber, Cass Gilbert, W. H. Nichols, New York; F. K. Copeland, C. F. Loweth, C. B. Burdick, Chicago; C. E. Grunsky, San Francisco; P. Junkersfeld, Morton C. Tuttle, Boston; Philip N. Moore, St. Louis; F. H. Newell, Urbana, Ill.; W. O. Winston, Minneapolis.

Committee on Text of Bill: M. O. Leighton, Washington, D. C., chairman; J. W. Alvord, A. S. Baldwin, E. H. Lee, I. K. Pond, Isham Randolph, Chicago; Charles T. Main, Boston; Lincoln Bush, New York; G. S. Williams, Detroit; W. K. Hatt, Lafayette, Ind.; H. V. Winchell, Minneapolis.

Campaign Committee [to be enlarged by Executive Committee]: M. O. Leighton, Washington, D. C., chairman; J. Parke Channing, F. S. Cranford, G. W. Fuller, E. J. Mehren, Robert D. Kohn, A. T. North, H. W. Buck, W. D. Blair, New York; C. H. Blackall, Boston; R. A. S. Penrose, R. H. Fernald, Philadelphia; Morris Knowles, Pittsburgh; W. C. Beahan, Cleveland; E. G. Bradbury, Columbus; Julius Stieglitz, W. A. Rogers, Chicago; Baxter L. Brown, E. J. Russell, St. Louis; W. H. Hoyt, Duluth; W. O. Hotchkiss, Madison; Lloyd B. Smith, Topeka, Kansas; W. C. Armstrong, St. Paul; Hennen Jennings, Washington, D. C.; H. S. Crocker, D. W. Brunton, Denver; R. H. Thompson, Seattle; C. F. Swigart, Portland, Ore.; W. L. Huber, Louis Mulgardt, Robert Sibley, F. W. Bradley, San Francisco; P. M. Norboe, Sacramento; J. C. Ralston, Spokane; R. C. Gemmel, Salt Lake City; George A. Damon, J. B. Lippincott, Los Angeles; J. C. Greenway, Bisbee, Ariz.; J. J. Knoch, Fayetteville, Ark.; J. L. Harrington, Kansas City; T. U. Taylor, Austin, Tex.; F. A. Jones, Dallas; W. B. Gregory, New Orleans; Wilmer Waldo, Houston, Tex.; J. F. Coleman, Mobile; L. C. Datz, Birmingham; E. F. Scott, Atlanta; S. B. Earle, Clemson College, S. C.; C. E. Ferris, Knoxville, Tenn.

Roster of Delegates to the Conference and Societies They Represented

Following is a list of the delegates to the conference:

W. L. Abbott,	Am. Soc. Mech. Eng'rs
W. C. Armstrong,	Eng'rs' Soc. of St. Paul and Minn. Surveyors' and Eng'rs Soc.
Warwick M. Anderson,	Eng'rs and Architects' Club of Louisville
Bion J. Arnold,	Soc. Automotive Eng'rs
A. S. Baldwin,	Am. Soc. Civil Eng'rs
W. D. Blair,	Am. Inst. Architects
E. G. Bradbury,	Eng'rs Club of Columbus and Ohio Engineering Soc.
Baxter L. Brown,	Eng'rs Club of St. Louis
Chas. Brossman,	Indiana Eng'rg Soc.
Webster B. Bushnell,	Eng'rs Club of Quincy
J. P. Channing,	Mining and Metallurgical Soc. of America
H. H. Clark,	Ill. Gas Ass'n and Am. Steel Treaters' Soc.
Louis Clousing,	Eng'ng Club of Minneapolis
F. K. Copeland,	Am. Inst. Mining and Met. Eng'rs
W. W. DeBerard,	Eng'ng Committee, Chicago Ass'n Commerce
Geo. C. Dent,	Soc. Industrial Eng'rs
F. W. DeWolf,	Am. Ass'n State Geologists
C. E. Drayer,	Nat'l Drainage Congress
W. H. Emmons,	Geological Soc. America
Frederic H. Fay,	Boston Soc. Civil Eng'rs
W. H. Finley,	Am. Ass'n Eng'rs
H. G. Gardner,	Am. Soc. Refrigerating Eng'rs
Lloyd Orr Goble,	Soc. Constructors of Federal Bldgs.
S. A. Greeley,	Am. Public Health Ass'n
W. B. Gregory,	Louisiana Eng'ng Soc.
C. E. Grunsky,	Pacific Ass'n Consult. Eng'rs
R. B. Harper,	Am. Gas Ass'n
Chas. H. Hammond,	Illinois Soc. Architects
Jas. N. Hatch,	Struc. Eng'rs Ass'n of Illinois
John L. Harrington,	Eng'rs Club of Kansas City
W. K. Hatt,	Am. Concrete Inst.
Jas. Herron,	Cleveland Eng'rs Soc.
C. J. Hogue,	Oregon Soc. Eng'rs
W. H. Hoskins,	Am. Inst. Chem. Eng'rs
W. O. Hotchkiss,	American Ass'n State Highway Officials
W. H. Hoyt,	Eng'rs Club of Northern Minnesota and Duluth Eng'rs Club
Peter Junkersfeld	Nat'l Elec. Light Ass'n
W. G. Kaiser,	Am. Soc. Agricultural Eng'rs
Lewis H. Kenney,	Eng'rs Club of Philadelphia
Frank B. Knight,	Brooklyn Eng'rs Club
E. H. Lee,	Am. Ry. Eng'rs Ass'n and Soc. Terminal Eng'rs
D. B. Luten,	Scientech Club of Indianapolis and Indiana Eng'rs Soc.
C. H. Mayer,	Swedish Eng'rs of Chicago
E. J. Mehren,	Am. Road Builders' Ass'n
Leonard Metcalf,	Am. Water-Wks. Ass'n
E. C. Millard,	Am. Civic Ass'n
F. H. Newell,	Washington Soc. Eng'rs
A. T. North,	New York Soc. Architects
C. E. Paul,	Nat'l Lumbermen's Mfg. Ass'n
E. T. Perkins,	Illinois Soc. Eng'rs
Willard F. Pond,	Rochester Eng'n'g Soc.
W. B. Powell,	Eng'n'g Soc. of Buffalo
Isham Randolph,	Franklin Institute and Western Soc. Eng'rs
A. M. Richter,	Indiana Limestone Quarry Ass'n
W. A. Rogers, Edw. Haupt (alternate),	Assoc. General Contractors of America
W. F. Schulz,	Memphis Eng'n'g Club
E. C. Shankland,	Am. Inst. Consulting Eng'rs
C. E. Skinner,	Am. Inst. Elec. Eng'rs
Lloyd B. Smith,	Kansas Eng'n'g Soc.
Julius Stieglitz,	Am. Chem. Soc.
F. W. Ullius,	Eng'n'g Soc. of Wisconsin
F. A. Vaughn,	Illuminating Eng'n'g Soc.
B. C. Wheeler,	Portland Cement Ass'n
G. S. Williams,	Detroit Eng'n'g Soc.
Sylvester N. Williams,	Iowa Eng'n'g Soc.

Engineering Council:

A. N. Talbot — Ira N. Hollis
C. E. Skinner — Philip N. Moore
C. F. Loweth — M. E. Cooley
N. A. Carle

National Service Committee:

Charles B. Burdick — M. O. Leighton
E. J. Mehren, *Engineering News-Record*

On the following pages will be found the introductory remarks by Mr. Channing and the report of the National Service Committee on the projected department:

Introductory Remarks at Conference on the Proposed Department of Public Works, by J. Parke Channing, Chairman of Engineering Council

This is the latest of a large number of conferences called together during the past half century for the purpose of considering and prosecuting a plan for a national department of public works.

The plans wrought by previous conferences have in many cases been admirably conceived, but they have come to naught for several reasons, the controlling one being that the engineers, architects, builders and constructive thinkers of the country have not given united support and have exerted no strong and persistent push behind the movement.

This conference is in many respects the greatest that has ever been brought together to consider an engineering project, being a conclave of 74 organizations representing a total strength of 99,304 men [revised figures put it at over 100,000], not mere idealists and exhorters given to the exploitation of intangible ideas, but practical, flat-footed men who know what they want and are accustomed to achieve. When we say that this is the latest of a series of conferences, we hope that if we are of determined mind this conference is the last that will be needed.

The last few months have created new conditions and emphasized new necessities—we shall never again tread the paths we trod two years ago; that the changes and reforms that we considered merely desirable then have become the real necessities of the present; that in the present and future urgencies and complexities our Government and our people can, if they would survive, tolerate only those methods and policies that are the most efficient, most business-like and most purposeful and must tear asunder from those which, however old and revered, are but the expedients of a former time inadequately expanded to render present-day service.

Our Government has become the greatest industrial plant in all history—investigating, surveying, building and operating—and its various functions are being conducted with practical independence one with another, and with so little coördination and so complete a lack of common purpose that practically the only occasions when the various elements become conscious of each other is when they overlap and attempt to crowd each other off the map; that any private or corporate business conducted according to the methods of Government would speedily become bankrupt and would deserve such fate. There are twelve Federal organizations engaged in making surveys, more than a score in chemical investigations, some of them competing and quarreling for preference under the same departmental roof. In the Congressional Directory there are listed 29 bureaus and agencies of Government engaged in construction of one or another kind. Four Government departments are engaged in fuel tests, while four Government bureaus are maintaining coast fleets each independent of the other, in the same waters, and engaged in work that has so many points of contact that not one person in twenty realizes that they are separate. These are only a few illustrations of a condition which can be tolerated by no considerate person.

We have come together, each qualified in his own line, to render service to the people, to point out the wastes and extravagances, the chaos and inefficiencies, and to offer some sane and practical solution to the country—so practical and so self-evident that it will carry its own conviction. To do this it will be necessary for each delegate to bear an open mind, and, while expressing freely the convictions that are his, to take part in that mutual concession which alone can bring concerted action among full-grown men.

Engineering Council has invited these conferees to meet for a common purpose and extends welcome, but it does not seek to dominate the deliberations—not even claiming the right to send a voting delegate. As chairman of the council I merely call the conference to order and preside until it effects its own organization.

Report of National Service Committee on the Project for a Department of Public Works, Presented by Philip N. Moore, of St. Louis

For a generation the dream of the civil engineers of this country, using the word in its ancient contrast with the first known form of the profession, represented by our military brethren, has been that one great department of our executive government, under the trained control of an experienced engineer, might achieve charge of all the nonmilitary engineering tasks of the nation. Time and again great engineer presidents, from their official pedestals, in salutatory and valedictory have voiced this vision. Time and again civilian subordinates doing civil-engineering work under military domination have raised their protests and complaints in the professional press and at our gatherings.

But, due to increased specializing of the profession and the engineer's desire, after he differentiated himself, to foregather with his colleagues, he has multiplied societies; and, while increasing their dividends to himself in personal acquaintance, relative influence and gratified vanity, he has not built up any organization with sufficient political potence to achieve in legislation the ideals of the profession.

Of the merits of some plan that shall coördinate under one head the vast engineering activities of the United States Government which now function through a dozen or more bureaus, directed by six secretaries, there will probably be in this meeting few opponents.

That opponents will be found elsewhere, fortified in power, we who favor shall soon realize.

Time Opportune for Realization

Never before were conditions so favorable for realization of this ideal. Reconstruction is a common thought and word. Engineers have borne a great and honorable part in the closing contest. Never before have their services been so publicly and generally recognized. Never before has there been so keen realization of the complexity and unsystem of engineering bureaus of the Government. Bureaus which in the past have competed with one another and grasped jealously for new activities and accompanying appropriations now approve a more logical system, while realizing that unification must leave some heads without bureaus.

Even one cabinet minister, head of more civilian engineers than any other officer in the world, has expressed the opinion that the change is not alone logical and economical but inevitable.

More than two years ago the United Engineering Society, representing the four great national bodies of the profession, with headquarters in New York, established a committee representative of all four to deal with all public matters affecting the engineering profession at large, to be called Engineering Council. That council, serving at first as a convenient referee for all the crank propaganda which came to the founder societies, and spending hours of its supposedly valuable time in saying "No" to impossible propositions, limited in its constructive work by financial resources so narrow that it could scarcely buy a new broom with which to sweep the ancient cobwebs from the windows of the engineering structure, where they had been accumulating since the days of Leonardo da Vinci, at last determined on a constructive task of the first order.

There was established a National Service Committee, with headquarters in Washington, for the purpose of finding opportunities of service to the nation on the part of the organized profession.

It chose ts first task—the establishment of a national department of public works. Such action has, of course, met criticism. Particularists unfortunately abound among engineers. Possibly the intense specialization of our training inevitably leads that narrow way; but one of the penalties thereof, equally inevitable, is restricted vision. Disregarding such protests in the interest of the profession at large (enabled by the generous and broadminded underwriting of one of our far-sighted brethren), the National Service Committee is functioning.

Its first effort to that end is the gathering to which I have the honor of speaking. If I be not mistaken, it is more representative of the profession than any hitherto assembled. Upon its decisions, and upon the support of the societies which it represents, will depend the speed with which we achieve our object. Engineering Council seeks support of the entire profession throughout the nation. If the unanimously expressed will of the council be followed by the founder societies, it will offer membership to every dignified recognized engineering society in the United States, and thereby become the true and powerful voice of the profession.

If we undertake it forget not, gentlemen, tnat our task will be successful in direct proportion as it is patriotic and unselfish, and that results which may come to the profession, of dignity, of national recognition, and of reward, will come more surely if we conduct our campaign with dignity and unselfishness. Engineering Council has opened the way. It has undertaken the task; it has climbed the barbed fence of false ethics; and has put the profession squarely into the great field of national policies or, if you choose to call it, national politics. In that field grow thorns and briars, as well as good grain. Engineering Council has put the hand of the profession to a new plow. It will not look backward; it will plow no crooked furrows. Some of them may be shallow; some of them may be faulty; but, from that field, unless the speaker be mistaken, gentlemen, there will come a harvest of efficient grain, which, but for the service of the profession, would never have been planted.

Upon you, gentlemen, and on those whom you represent, will rest the result. From you must come the power which keeps that plow in the furrow. Without your support the tough clay of poverty or the ancient stumps of professional particularism and conservatism may halt it.

Unless your speaker be a false prophet, it can be halted only for a time. Under some other impulse, the action will be renewed. Coördination and simplification of the present complex situation in national service must come in the end. It can be delayed. It cannot be stopped. It is inevitable. It were better for the honor of the profession, for our own self-respect, that we, and we alone, carry it through. In your hands, gentlemen, the task abides. To its discussion, broadminded and without selfishness, the National Service Committee invites you.

Miami Conservancy Construction Work Not Damaged in Flood

A HEAVY storm over the valley of the Miami River in Ohio, Mar. 15-17, with a total precipitation of 3½ in., caused a sharp flood in the Miami River and its tributaries, where the conservancy district flood-protection works are now being built. The conservancy construction plans had from the start been developed in such a way as to take account of the likelihood of floods of every magnitude (up to that of the extreme 1913 flood); the five dams of the project are the critical points, both with respect to damage to the work under construction and damage to the property in the valley, while the levee and channel-widening operations are a minor factor. The precautions taken in the planning proved to be ample for all conditions imposed by the March flood. A description of the storm and of its effect on the work in progress is given in the April, 1919, issue of the *Miami Conservancy Bulletin.*

Forecaster and flood-warning service provided by the district gave effective notification of the coming storm and probable flood to the construction offices and to the communities and inhabitants of the valley. All construction plant was promptly made safe or, as in the case of excavators in exposed positions, moved back to safer ground.

Pump installations at the construction cofferdams were in most cases so low that the motors were likely to be flooded. Provision for this risk had been made at the time of building the pump houses, by setting beams over the motors so that at any time these machines could be lifted up above flood level. At Taylorsville this was done after the first 24 hours of rainfall, the motors being hoisted up 4 or 5 ft. and lashed in place. Elsewhere extra pumping was done to cut down excessive seepage through cofferdams and permit the resumption of concreting without delay.

The dragline excavators on channel work at Dayton and Hamilton, three or four of which were at work in the channel, were not underscoured or otherwise injured. Slight wash of the new levees occurred in both cities at the level of the top of the flood.

In substance, the effect of the flood upon the construction work was limited to producing from one to five days' delay in the operations, and calling for a small amount of extra work to make plant and materials safe before the water rose.

Reorganization of the Engineering Standards Committee

Effect of Engineering Standards Movement on Technical Societies—Reorganization to Give Broader Representation—Association May Be Formed To Elect the Committee—Formulating Safety Codes

By Edward B. Rosa
Chief Physicist, Bureau of Standards, Washington, D. C.

For the first time an explanation of the American engineering standards movement is presented to engineers. Dr. Rosa, to enlist general support of the movement, tells of the organization of the committee formed last October, and of its proposed broadening into an association. This proposal, now before the councils of the societies, is to be acted upon in the near future. Together with Prof. C. A. Adams and H. W. Forster, Dr. Rosa served on a committee which prepared plans for consolidation of the safety-code conference with the standards committee. Having been intimately concerned with all phases of this planning, he writes from the fullness of knowledge. In the absence abroad of Professor Adams, the leader in the standards committee movement, no more commanding utterance on the subject could be offered to engineers than the present.—Editor.

TWO recent editorials in *Engineering News-Record* (April 10 and 17, 1919, pp. 700 and 751) discuss the relations of engineering societies to the American Engineering Standards Committee, particular reference being made to the American Society for Testing Materials. The suggestion is made that the influence upon this and other societies of the Engineering Standards Committee, especially as it is proposed to be reorganized, would be harmful, and that these societies would do well to reconsider their action in establishing this committee.

If participation in the work of the committee and closer coöperation with other engineering bodies should lead to a decline in the influence and usefulness of the American Society for Testing Materials, it would be unfortunate; if it had the same effect also on all the other strong and useful engineering societies concerned, it would be a calamity. But I believe the result will be the opposite, and that these societies will be strengthened, and not injured. Without question, the work of engineering research and standardization in this country will receive a powerful impetus if the present plans for the reorganization of the American Engineering Standards Committee are approved by the founder societies and carried out in the spirit in which they are conceived. Unfortunately, these plans, so very recently formulated, are not yet generally understood.

Principles of the Standards Association

The cardinal principles of the proposed American Engineering Standards Association are fair play and coöperation. Each society retains its integrity and initiative, and yet recognizes the existence and the rights of others; each society or Government body manages certain work of research and standardization itself as now, but with the coöperation of representatives of other agencies invited to participate because of their interest in the subject and the information they can furnish. The practicability of this method of standardization has been abundantly demonstrated by the American Society for Testing Materials itself, as well as by the American Institute of Electrical Engineers, the Society of Automotive Engineers and other engineering bodies. Indeed, one can truly say that the procedure of the proposed new organization is almost identical in principle with that of the American Society for Testing Materials, but expanded and applied to a large number of organizations acting in harmony, with a definite method for preventing or dealing with conflicts, and with a democratic spirit pervading the whole.

Need for a Coördinating Agency

The authority of the American Society for Testing Materials and other societies, which they enjoy by virtue of the representative character of the men composing their committees and the quality of their work, will remain undisturbed by the new organization. The Engineering Standards Committee will approve a standard because it is certified by some sponsor society and its coöperating committee, not because the central committee has itself examined it and passed an independent judgment upon it, which that committee will not attempt to do. The quality standards of the American Society for Testing Materials, the electrical standards of the American Institute of Electrical Engineers, the codes and standards of the Bureau of Standards, will derive their authority largely from the reputation of the sponsor bodies that prepare and certify them. They will, however, possess the added advantage that the Engineering Standards Committee, made up of representatives of all engineering and commercial interests and the Government, will certify that the procedure of the committee has been complied with, that all interests concerned have been heard and there is every reason for accepting the sandard and putting it into general use. This guarantee by a thoroughly competent and authoritative body will be worth much, even in the case of the strongest societies and Government bureaus.

In addition to a few conspicuous societies and Government departments concerned in the making of standards, there are scores of others that coöperate in and to some extent initiate such work. Heretofore each has had to find out for itself what work other societies were doing or contemplating, and establish connections as best it could for coöperation or for adjusting matters of conflict. There has been no central agency to keep a record of all standardization work in progress or being organized, to assist in securing the proper degree of coöperation and to avoid conflict and duplication of effort. The need for such a central coördinating agency has been felt for years; it was only a question of how it should be realized. The present committee has not yet attempted to meet this need. The reorganization proposed looks toward accomplishing this important result in an adequate manner.

The British Engineering Standards Committee has been in successful operation for a number of years and

has been carefully studied by American engineers. It largely initiates research, appoints the chairman of the committee for a particular piece of work and nominally, at least, supervises the work. It was generally agreed that conditions here in America favored a different method of procedure. Engineering and commercial organizations and Government departments were already active in standardization work, and were in many cases coöperating in a very satisfactory manner with one another, as has been pointed out by *Engineering News-Record*. It was desirable to continue and extend the methods that had been found successful rather than to set up a new method.

The procedure adopted by the American Engineering Standards Committee leaves the initiation and management of the work, and the selection of the coöperating committee, with the sponsor society. This sponsor society may be any responsible agency competent to do the work and entitled to do so by virtue of its relation to the subject. The Standards Committee advises and approves, and having done so will support and encourage the sponsor body in its work. But it does not control the sponsor body, and should not in any way embarrass it.

Reasons for Reorganization

The present Engineering Standards Committee is composed of 15 men of the highest standing who represent five leading engineering societies; it was planned also to have representatives of the Government. If no one objected to having so restricted a committee perform the important functions of coördinating and encouraging engineering standardization by all private and Governmental agencies, and dealing with similar organizations in other countries on questions of international standardization, there would have been less occasion to reorganize the committee.

To be sure, a larger representation would secure a more generous financial support and better coöperation in creating standards and getting them into use. Nevertheless, if everybody was satisfied and the small committee had the confidence and good will of all the interests concerned, and was willing to give it the requisite amount of time, it could have gone along with its work successfully and satisfactorily. It appeared, however, that such was not likely to be the case.

Ours is a democratic country, and this is a democratic age. We believe in equitable representation. To be successful in the performance of its important functions an engineering standards committee should be representative of all the interests concerned and should be supported by a strong public sentiment.

This, it appeared, could only be secured by giving representation to all organizations and Government departments interested in the preparation of engineering and industrial standards. The larger societies should, of course, have a larger number of representatives than the smaller. Since there are many scores of societies and Governmental agencies that may be expected to desire representation in such an organization, it would obviously soon become too large for a working standards committee. The evident procedure was to call the large representative body an association instead of a committee, and let there be formed within the association a standards committee.

The association should then be subdivided into groups or divisions. The details of such subdivision have not been agreed upon, but for the sake of a clear conception of the work of the association there can be no harm in describing one plan that was submitted to the committee for consideration.

Suggested Divisions of the Association

According to this plan, there would be 10 divisions of engineering and industrial organizations and two representing the Government, as follows:

1. Electrical engineering and electrical industries.
2. Mechanical engineering and allied industries.
3. Mining and metallurgy and allied industries.
4. Civil engineering, architecture and building.
5. Chemical engineering and chemical industries.
6. Materials of construction (A. S. T. M. division).
7. Miscellaneous manufactures.
8. Steam and electric transportation.
9. Automobiles, aircraft and other automotive vehicles.
10. Fire protection and safety engineering.
11. Federal bureaus and commissions.
12. Associations of state and municipal agencies.

The divisions would contain in some cases five to 10 and in other cases as many as 20 or more national societies and manufacturers' organizations having a certain common interest. Two or three examples of such divisions may be mentioned, to illustrate its working.

Electrical Division—There would be from 10 to 20 national engineering societies and manufacturers' organizations in the first division, of which the American Engineers is most conspicuous and most active in matters of electrical standardization. Its Standards Committee has a splendid record of achievement and carries on its work in a spirit of fair play and coöperation. The institute invites into its Standards Committee as coöperating members representatives of the Illuminating Engineering Society, the Institute of Radio Engineers, the Electric Power Club, the Bureau of Standards, and other organizations having an interest in the subjects covered by its standardization rules. Sometimes general agreement is difficult to secure; in such cases discussion and study of the question are continued, investigations are undertaken if necessary, and the subject is not considered settled until substantial unanimity is reached. Some of the members of the committee represent large or small manufacturing interests, others are consulting engineers, college professors, Government officials. It would be difficult to find, anywhere, a finer example of a standards committee which is thoroughly representative, competent, energetic and imbued with high ideals.

If the standards association comes into existence with its central standards committee, the committee of the Institute of Electrical Engineers would go on with its work just as now, reporting to the board of directors of the institute as heretofore. The board would approve the work and transmit it to the association for its approval, having previously submitted the names of the men representing other organizations which sit in its Standards Committee, so that it would be evident that all interests are represented and that standards prepared by such a committee deserve to be approved and to be labeled "American Standards." In fact, the procedure of the American Engineering Standards Committee was devised expressly with this in view, for it was recognized that any requirement that seriously embarrassed the work of the large engineering societies would be fatal to the success of the movement.

(To Be Concluded)

Cost-Plus Contract Incentive To Close Management

Contractor Creates a Clientele of Customers and Not Merely a Chance to Bid Again, Says Prominent Cost-Plus Advocate

(Editorial Interview)

IS THERE a greater incentive to good construction management in the cost-plus contract than in the lump-sum contract? Discussing this question with the editor, Morton C. Tuttle, of the Aberthaw Construction Co., developed a line of thought which, though possibly not new, will repay attention by contractors. For the concern performing the whole or a large part of its work on a cost-and-profit basis, there is, asserted Mr. Tuttle, a tremendous incentive to satisfy each engineer or owner for whom work is done. Then he continued:

It is clear that the anxiety which a contractor feels for his own financial interests may vary greatly as between a lump-sum and a day-work contract. If he is satisfied to do one job for one customer and to leave that customer dissatisfied, he undoubtedly has a chance on a cost-plus contract to pile up cost, and, short of provable negligence, will be reimbursed for all expenses incurred. At the end of the job he will receive the agreed profit and will be left with an impaired good-will. A few repetitions of this situation should remove him completely from the field of cost-plus work. It is inconceivable that large jobs will be placed with any contractor until after his references have been thoroughly looked up.

One dissatisfied customer will prevent a great deal of future profit. In one case which has received rather wide publicity a dissatisfied customer had a considerable part in ultimately bankrupting a once prominent building concern

Builds Up a Clientele—It is apparently not clearly understood in the building trade that a reputation for carrying on honestly and successfully—and, above all things, economically—a cost-and-profit business leads to the establishment of a clientele of customers who turn all their work to a concern which has once satisfied them. In the case of my own company 58% of our business in the past five years has come from concerns for which we have worked before, and very commonly we do all building work for many of these customers. Had our business been done on a bid basis we should have earned with each of these customers simply a chance to bid again. To establish business relationships as intimate as this, leads necessarily to vigilance as to each detail of every operation. A concern carrying on cost-and-profit work primarily must be honest, and it must have vision enough to understand the necessity of carrying on its work satisfactorily to each and every engineer and owner. It is so easy to start a reputation for extravagance, for inefficiency or for careless workmanship that vigilance has to be exercised at all times. To allow slackness on any one job, or to allow higher costs than are justifiable, would be suicide.

The two types of contract are really difficult of comparison. Under the percentage form of contract it will be assumed that the engineer or architect has specified exactly what he wants and is entitled to exactly that which he has described. Under the lump-sum form of contract an attempt is commonly made to see how far it is possible to depart from the more expensive items specified. The questions of allowances and extras are always troublesome and generally are not frankly handled. With the lump-sum contract there is a tendency to give less thought to the quality of the work and more thought to the first cost—a procedure which shows up later in the cost of upkeep. With the lump-sum contract there is less coöperation between the engineer and the builder, a condition which has again and again resulted in needless expense, loss and faulty workmanship.

That the quality of work should be better under the cost-plus form of contract is undoubted. As to cost, it would be interesting to see a tabulation showing the bid prices and the final costs of, say, twenty-five jobs. Very commonly the original bid and the final cost would not be recognizable as applying to the same work.

No Perfect Lump-Sum Contract—Some day, so close to the millennium that the question of building shelters may be neglected, some engineer or some architect will make an absolutely clear set of plans and specifications which will describe accurately some big job from start to finish. Then he will invite a limited number of perfectly honest and perfectly competent contractors to make independent and honest estimates, each estimate to contain a reasonable item of profit, and with these estimates will come an honest statement of the length of time each of these contractors will require to carry out that work. Under these conditions, we shall all agree, the lump-sum contract is a most excellent thing because an honorable concern has employed an infallible engineer and architect to describe exactly what it will require and an honest and able contractor has agreed to furnish these things, and has assured himself of a reasonable profit for furnishing them exactly without substitution.

Until this combination is secured there will be a good chance to argue with any owner that he is more likely to get what he wants in the time in which he wants it by some arrangement which secures the coöperation of his contractor with his engineer, with the assurance on the part of both that they will be reasonably compensated for the work that they do.

Efficient Labor Due to Efficient Supervision—The common explanation of any slackness of labor on a cost-plus job is that the laborers know that their employer's interest will not suffer if they loaf upon that particular job. To anyone familiar with the building trade, how much anxiety labor feels toward the financial interests of its employer is a subject for profound speculation.

As to the performance of the labor under the two forms of contract, it seems reasonable to suppose it will produce the most economical and satisfactory results on the job where it is best directed and best led, regardless of the contract arrangements. C. S. H.

British Women Engineers Organize Union

British women engineers, one of the war discoveries, have banded together in the Women's Engineering Society, a trade union. The women want, among other things: Admission to the Amalgamated Society of Engineers; to become members of institutes of civil engineers, naval architects, iron and steel and other bodies now closed to women; to serve on the boards of universities, and to become eligible for technical branches of the higher civil service.

A New Principle in the Theory of Structures

Professor George F. Swain Gives Formula for Computing the Rotation in Elastic Distortion Similar to That for Deflection

MAKING use of the principle underlying the Maxwell reciprocal theorem, Prof. George F. Swain of Harvard University gives in the March issue of the *Proceedings* of the American Society of Civil Engineers, p. 75, a new formula similar to that by which the deflections of trusses and other frames are determined, but defining distortional rotation instead of deflection. Like the deflection formula, it may be used in connection with the problem of computing the stresses in constrained (statically indeterminate) frames, by first computing the distortion when the constraint is removed and then finding the moment required to neutralize this distortion. The formula is simple and easily remembered, being a close analogue of the deflection formula.

As first published in this country by Professor Swain in 1883 (in the *Journal of the Franklin Institute*), the formula for deflection at any point of a frame is

$$\Delta = \Sigma \frac{stl}{EA}$$

in which t = stress in a member due to a load of unity acting at the point whose deflection is desired, and acting in the direction of that deflection;

s = stress in the same member from the actual loading.

l, A, E = length, sectional area and modulus of elasticity of the member.

In the case, for example, of an arched roof truss over an assembly hall, where it may be desired to find the horizontal movement of the expansion end due to the loads on the truss, the procedure would be as follows: Apply a horizontal outward force of 1 lb., at the two ends of the truss, and find the stress in each member due to this force, calling such stress t; compute the stresses in the several members under the actual roof loads and call them s; then obtain the product stl for each member, divide by the sectional area and by the modulus of elasticity, and add the resulting figures for all members of the truss. The result will be the horizontal outward deflection of the truss in inches, provided the lengths of the members, l, were taken in inches.

The method implied by this formula is applicable also to solid members in flexure; for this case, if M_t is the bending moment at any section caused by unit force acting at the point of deflection in the direction of the desired deflection, M_s is the bending moment at the same section due to the actual loads, and I is the moment of inertia of that section, then

$$\Delta = \int \frac{M_s M_t dl}{EI}$$

The New Formula—When the angular rotation of any point in a member or a frame is to be computed, the new formula now proposed by Professor Swain furnishes a means. The formula in its simplest form is

$$\alpha = \Sigma \frac{rsl}{EA}$$

in which r = stress in any member of length l and cross-section A produced by a couple of unit moment acting at the point whose rotation is desired and in the direction of the desired rotation;

s = stress in the same member produced by the applied loads.

The formula is derived as follows: Apply at the point of rotation a unit moment, and consider the (external) work expended by this moment in rotation. It equals the product of the moment by half the rotation α_1 (in angular measure), since the moment is bound to increase uniformly from zero to its full value of 1 as the distortion comes into existence; or $W_e = \frac{1}{2}\alpha_1$. The work of the internal forces must be just equal to this amount. If r is the stress in any member of the structure caused by this unit moment, and Δl_1 its change of length, then the internal work of that member will be $\frac{1}{2}r\Delta l_1$, and the total internal work for all members will be $W_i = \frac{1}{2}\Sigma r\Delta l_1$. Equating this to the external work,

$$\tfrac{1}{2}\alpha_1 = \tfrac{1}{2}\Sigma r\Delta l_1, \text{ or } \alpha_1 = \Sigma r\Delta l_1$$

It follows that under the action of this unit moment the rotational distortion α_1 due to the deformation of *any one member alone* is $\alpha_1 = r\Delta l_1$. However, there is a purely geometrical relation between the angular rotation at the point of the structure in question and the change of length of any member, irrespective of the kind of loading. Therefore the change of length produced in that member by any other system of loading will bear the same proportion to the resulting rotational distortion as in the above expression. Then if the change of length Δl due to the actual loads on the structure be substituted for the value Δl_1, the angular rotation α_1 due to unit moment may be replaced by the actual rotation α due to the actual loading, or $\alpha = r\Delta l$. Now the change of length Δl under the actual loads, which produce the stress s in the member, will be $\frac{sl}{AE}$, and upon inserting this value in the preceding expression,

$$\alpha = \frac{rsl}{EA}$$

Summing this expression for all members of the structure the result is the total actual rotation of the point in question, or

$$\alpha = \Sigma \frac{rsl}{EA}$$

In this expression r is the stress on the member of length l and cross-sectional area A produced by a couple of moment unity acting at the point whose rotation is desired, while s is the total stress in the same member due to the applied loads.

As here demonstrated, the formula applies only to the case of direct (axial) stress in every part of the structure. For the general case, where there is bending as well as direct stress in any or all parts, the quantities r and s must be expressed by the products of the actual unit stress at the different points of each cross-section of the member multiplied by the element of area; for example, when the direct stress is T_s and the bending moment M_s, the product in question for a point at distance y from the neutral axis of the cross-section is

$$s = \left(\frac{T_s}{A} + \frac{M_s y}{I}\right) dA$$

and similarly for r. Inserting these values in the above equation and carrying out the multiplication, it will

be found that certain terms of the result vanish because the integral of $y\,dA$ is zero for an axis passing through the center of gravity of the cross-section (the value of the moment of inertia, I, is of course also computed around a gravity axis). The final result is

$$a = \Sigma \frac{T_s T_r l}{EA} + \Sigma \int_o^l \frac{M_s M_r dl}{EI}$$

Because of the way in which the products of the direct stresses under actual and hypothetical loading, and the products of the corresponding moments, appear in this equation, it is evident that the *flexure in any member of the structure may be neglected unless* both the actual loads and the hypothetical unit moment cause flexural stress in it. Similarly, the *direct stress in any member may be neglected unless* both the actual loads and the hypothetical unit moment produce a direct stress in it.

When every member is uniform in cross-section from end to end, the integral sign in the first member of the above expression disappears, and the differential dl is to be replaced by l, the length of the member.

Several illustrations of the application of this principle are given by Professor Swain. One of these may be cited here to aid in understanding the formula.

To find the slope at the right end of a beam of constant cross-section loaded with a single concentrated load P at a distance a from the left end, the span of the beam being l. The left-hand reaction will be $P(l-a)/l$, and the moment at any section to the left of the load, at a distance x from the left end, will be $M_s = Px(l-a)/l$. Similarly, in the right-hand segment of the beam the moment is $M_s = P(l-x)a/l$. For an applied unit moment (anti-clockwise) at the right-hand end, balanced by appropriate vertical reactions of $1/l$ at the ends of the beam, the moment at any point of the beam will be $M_r = x/l$. Using these values in the formula, the first term disappears because there are no direct stresses to be considered. The rotation therefore is

$$a = \int_o^l \frac{M_s M_r dl}{EI} = \frac{1}{EI}\left[\int_o^a \frac{Px(l-a)}{l}\frac{x}{l}\,dx + \int_a^l \frac{P(l-x)a}{l}\frac{x}{l}\,dx\right] = \frac{1}{EI}\left[\frac{P(l-a)}{l^2}\frac{a^3}{3} + \frac{Pa}{l^2}\left(\frac{l^3}{2} - \frac{la^2}{2} - \frac{l^3}{3} + \frac{a^3}{3}\right)\right] = \frac{Pa}{6EIl}(l^2 - a^2)$$

Other cases of beams, and cases of trusses, may be dealt with just as simply.

Six Years of Rapid-Transit Progress in New York

Construction Enterprise Greater Than Panama Canal Carried On at Remarkable Rate Despite War Interference—Over Four Times as Much Work Accomplished as On Old Subway

By D. L. Turner

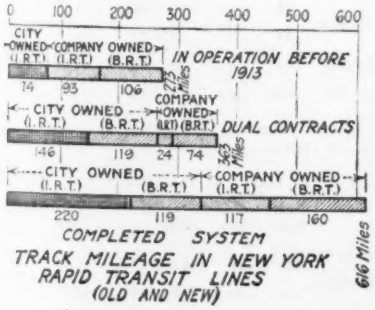
Chief Engineer, Public Service Commission for First District, New York City

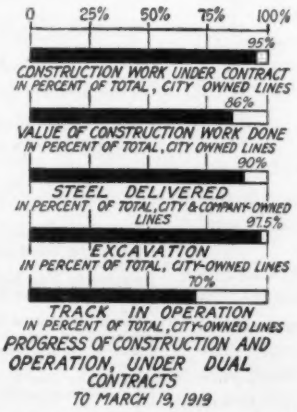
In the six years since the signing of the dual contracts for rapid-transit construction and operation in New York City, the system involved in those contracts has been nearly completed. In terms of total cost for labor and material of city-owned lines (excluding car-storage yards) it is approximately 86% complete; in terms of excavation on city-owned lines, the largest single item of expense in subway construction, 97½% complete; in terms of steel, the largest single item of material, 90% complete. Of the entire mileage, 95% is under contract and 70% of the total track mileage to be constructed or reconstructed is now in operation.

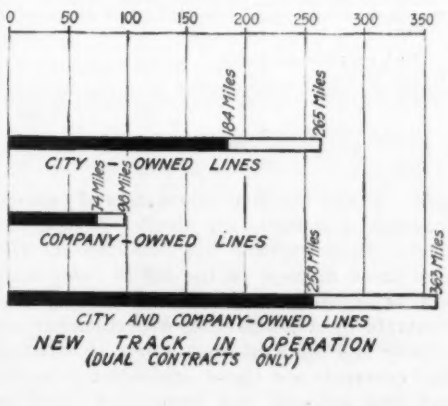
Approximately as much newly constructed track has already been put in operation as was being operated in 1913 in the subway and on all elevated lines in New York and Brooklyn combined.

Under the most favorable conditions this would be a noteworthy accomplishment. But when it is remembered that one year and four months after the dual contracts were signed the world war began, and that for one-third of the six-year period this country has been a participant in the world's greatest war, involving as it did the almost immediate and complete diversion of all kinds of material and manpower to war work, the achievement is nothing short of remarkable.

Old and New Rapid Transit Systems—Under the dual contracts, signed Mar. 19, 1913, six years ago, the city entered into a partnership with two rapid-transit companies whereby city and companies joined in the con-




0 25% 50% 75% 100%
95%
CONSTRUCTION WORK UNDER CONTRACT IN PERCENT OF TOTAL, CITY OWNED LINES
86%
VALUE OF CONSTRUCTION WORK DONE IN PERCENT OF TOTAL, CITY OWNED LINES
90%
STEEL DELIVERED IN PERCENT, OF TOTAL, CITY & COMPANY-OWNED LINES
97.5%
EXCAVATION IN PERCENT OF TOTAL, CITY-OWNED LINES
70%
TRACK IN OPERATION IN PERCENT OF TOTAL, CITY-OWNED LINES
PROGRESS OF CONSTRUCTION AND OPERATION, UNDER DUAL CONTRACTS TO MARCH 19, 1919



FIGS. 1, 2 AND 3. 1, NEW YORK'S RAPID-TRANSIT SYSTEM MUCH MORE THAN DOUBLED BY DUAL CONTRACTS; 2, CONSTRUCTION UNDER DUAL CONTRACTS NEARLY COMPLETED; 3, OVER TWO-THIRDS OF NEW MILEAGE ALREADY IN OPERATION

struction of new subways and elevated railways, and in the third-tracking, reconstruction and extension of the existing elevated lines, with provision for pooling receipts and expenses and sharing net returns on the entire unified systems (excepting only the old tracks of the Manhattan elevated lines). To protect the city's interests in this partnership arrangement the Public Service Commission was charged with the direct and full supervision of the construction of all city-owned lines and a general supervision of all company work, which included reconstructing, third-tracking and extending the company-owned lines, and equipping the entire system. The magnitude of this project and the progress which has been made in the six years since the signing of the contracts are illustrated by the accompanying maps, diagrams and tables.

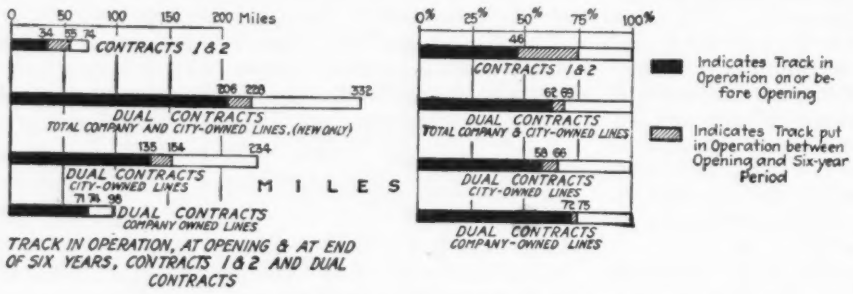

0 50 100 150 200 Miles
CONTRACTS 1&2
DUAL CONTRACTS
TOTAL COMPANY AND CITY-OWNED LINES, (NEW ONLY)
DUAL CONTRACTS
CITY-OWNED LINES
DUAL CONTRACTS
COMPANY OWNED LINES
M I L E S
TRACK IN OPERATION, AT OPENING & AT END OF SIX YEARS, CONTRACTS 1&2 AND DUAL CONTRACTS
0% 25% 50% 75% 100%
CONTRACTS 1&2
DUAL CONTRACTS
TOTAL COMPANY & CITY-OWNED LINES
DUAL CONTRACTS
CITY-OWNED LINES
DUAL CONTRACTS
COMPANY-OWNED LINES
Indicates Track in Operation on or before Opening
Indicates Track put in Operation between Opening and Six-year Period

FIG. 4. COMPARISON OF WORK ACCOMPLISHED IN SIX YEARS, 1900-1906 AND 1913-1919

Contract No. 1 signed Feb. 21, 1900; opening, Oct. 27, 1904 or 4⅔ years after signing. Dual contracts signed Mar. 19, 1913; opening of "H" system, Aug. 1, 1918 or 5⅓ years after signing. The diagram does not include the trackage on the East River bridges and sections of the Fourth Avenue (Brooklyn) subway and Centre Street Loop under contract prior to Mar. 19, 1913.

Six years ago, on Mar. 19, 1913, there were in operation about 273 miles of track on all the rapid-transit lines. Under the dual contracts and related certificates provision was made for about 363 miles of additional track. Both systems are itemized in Table I. The total track mileage on the entire rapid-transit systems will be approximately 616 miles of single track. To illustrate by a comparison with familiar distances, the subway and elevated lines being constructed under the dual contracts are about equivalent to a two-track subway and elevated line from New York to Baltimore or more than a similar four-track line from New York to Philadelphia. The total system (including old and new lines) when complete would form approximately a four-track line from New York to Philadelphia with a two-track extension to Washington. The diagram, Fig. 1, shows graphically the relative magnitude of the project compared with the subway and elevated lines in operation six years ago, which had been constructed piecemeal over a period of nearly half a century.

As Compared With Panama Canal—Heretofore the Panama Canal has been considered our largest construction undertaking. As a matter of fact, the dual subway project, while not as romantic as the joining together of two oceans, surpasses it in size and intricacy. It will cost more, and the engineering difficulties have been greater and more complex. One of the great difficulties in the Panama Canal construction was the sliding of earth into the canal after the excavation had been nearly completed. To picture the relative difficulties of the two projects imagine the catastrophe that would have resulted from even a relatively small slide of earth into a partially completed subway cut. Remember that the foundations of many buildings 20 or more stories in height have been rebuilt. Then add the fact that the subway construction has been carried on under the streets practically without interference with their use, so that few of New York's population passing daily over these streets have had a glimpse beneath the surface at the gas and water pipes, electric

TABLE I. NEW YORK'S RAPID-TRANSIT SYSTEM IN 1913 AND AFTER COMPLETION OF DUAL CONTRACT LINES (EXCLUSIVE OF YARDS AND SIDINGS)

	Miles Single Track
Lines in Operation Mar. 19, 1913	
City-owned subway and elevated extensions operated by Interborough Rapid Transit Co	74
Manhattan elevated lines	93
Brooklyn Rapid Transit Co. elevated lines	106
Total, all rapid transit lines	273
New Rapid-Transit Lines According to Dual Contracts	
Company-Owned Lines	
Manhattan elevated lines, third-tracking and extensions	24
Brooklyn elevated lines, reconstruction, third-tracking, and extensions	74
Total, company-owned lines	98
City-Owned Lines	
For Interborough R. T. Co. operation	146
For New York Municipal Ry. Corporation (B.R.T.) operation	119
Total, City-owned lines	265
Grand total under the dual contracts and related certificates	363

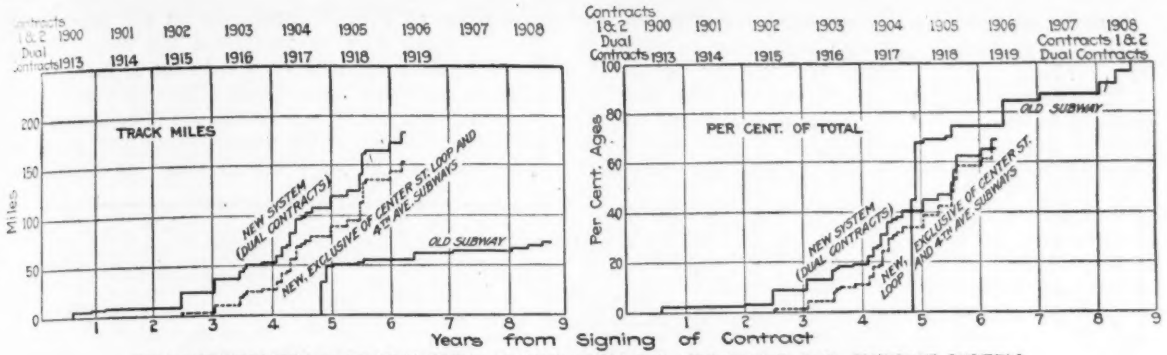
TABLE II. TOTAL MILES OF ROUTE AND TRACK TO BE CONSTRUCTED UNDER THE DUAL CONTRACTS AND THE PORTION IN OPERATION MARCH 19, 1919 (EXCLUSIVE OF CAR STORAGE YARDS, SIDINGS, ETC.)

Including Centre Street Loop and Fourth Avenue (Brooklyn) Subway

	Total		In Operation March 19, 1919			
	Track Miles	New Route Miles	Track Miles	%	New Route Miles	%
City-owned Lines						
Operated by Interborough R. T. Co.	146	48	104	71	34	71
Operated by New York Municipal Ry. Corporation	119	42	80	67	25	60
Total, City-owned lines	265	90	184	70	59	66
Company-owned lines						
Operated by Interborough R. T. Co.	24	4	21	87	2.5	62
Operated by New York Municipal Ry. Corporation	74	32	53	72	22	69
Total, Company-owned lines	98	36	74	75	24.5	68
Total, all lines	363	126	258	71	83.5	66

Excluding Centre Street Loop, and Fourth Avenue (Brooklyn) Subway, contracted for prior to Mar. 19, 1913, and as in operation Mar. 19, 1919

	Total		In Operation March 19, 1919			
	Track Miles	New Route Miles	Track Miles	%	New Route Miles	%
City-owned lines						
Operated by Interborough R. T. Co.	146	48	104	71	34	71
Operated by New York Municipal Ry. Corporation	88	34	50	57	17	50
Total, city-owned lines	234	82	154	66	51	62
Company-owned lines						
Operated by Interborough R.T. Co.	24	4	21	87	2.5	60
Operated by New York Municipal Ry. Corporation	74	32	53	72	22	69
Total, company-owned lines	98	36	74	75	24.5	68
Total, all lines	332	118	228	69	75.5	64



RELATIVE PROGRESS IN PLACING TRACK IN OPERATION, OLD SUBWAY AND DUAL CONTRACT SYSTEM

FIG. 5. NEW RAPID-TRANSIT LINES PLACED IN OPERATION PROGRESSIVELY DURING CONSTRUCTION PERIOD

Contracts Nos. 1 and 2 include old subway from Atlantic Avenue to Bronx Park and Van Cortlandt Park.

conduits and other structures which had to be maintained in constant use in order that the life of the city might go on unaffected by the gigantic work progressing rapidly under its feet.

For construction, the city-owned lines were divided into 87 major sections, of which 83 sections, or 95%, have been contracted for (Fig. 2). Of the four remaining, the two sections of the Nassau St. line have been temporarily postponed on account of war conditions; one section, extending the Queensboro Subway to Times Square, could not be undertaken until after the opening of the main east-side and west-side subways (Interborough), and its beginning then was deferred because of the war; and on the fourth, the elevated extension of the 14th St. Eastern line, bids were received and rejected for lack of sufficient engineering force to supervise the work properly. Contracts for station finish and track have been let, and the installation of equipment by the companies has proceeded as rapidly as the progress of the work under the construction contracts permitted.

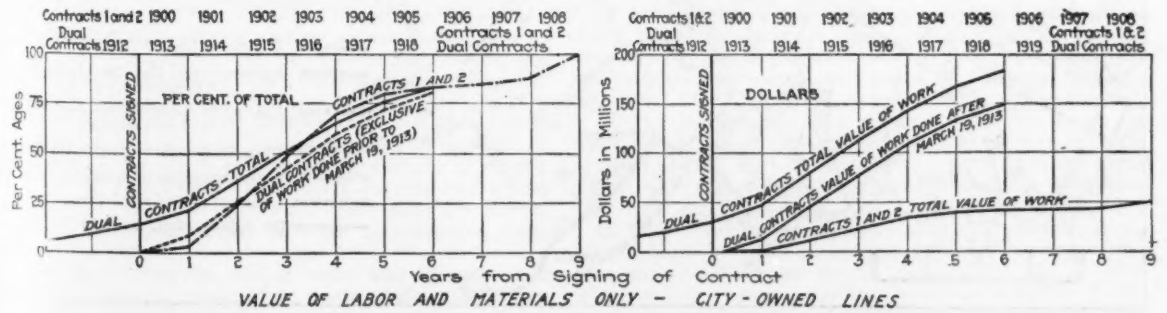
Expenditures to Dec. 31, 1918, for construction, additions, extensions and equipment (including interest and sinking-fund charges, superintendence, etc.), total about $375,000,000, which is between 80% and 90% of the total present estimated cost of all construction and equipment required for full operation under the dual contracts. On city-owned lines the expenditures for labor and material, the truest measure of progress of actual construction, total 86% of the entire estimated cost for these items, excluding car-storage yards, or 84%, including these yards.

A further idea of the actual advancement of the construction may be gained from the progress which has been made on two of the main items, excavation and steel. Excavation is by far the largest single item of expense in subway construction, and steel is by far the largest item of material entering therein (in elevated-railway construction the cost of steel is several times greater than the cost of all other items combined).

Excavation and Steel—Although one elevated and three subway sections have not yet been contracted for, the total excavation required for the city-owned lines is 97½% completed. The total excavation will be approximately 15,100,000 cu.yd. of earth and rock, excavated partly in tunnels under the river, partly in rock tunnels far below the streets, but chiefly immediately under the temporary street surfaces. This excavation is equivalent to a circular hole 3½ ft. in diameter 8000 miles long or a distance equal to the diameter of the earth, and the material excavated, if uniformly spread out over Manhattan Island, would form a layer nearly a foot deep.

The dual project, including city- and company-owned lines, when completed will have required the use of approximately 675,000 tons of steel, of which over 600,000 tons, or a little less than 90%, has already been delivered in New York. This steel would construct 21 buildings similar to the Equitable Building (the largest in the world) and to transport it would require approximately 30,000 cars, which would form a continuous train from New York to Washington.

Progress in placing lines in operation, in terms of miles of single track, miles of new route, and the percentage of each as compared with the total is shown in Table II. It should be noted in this connection that additional miles of track placed in operation indicate in a general way additional service, while additional route mileage indicates in a general way additional territory served.


PER CENT. OF TOTAL
CONTRACTS SIGNED
CONTRACTS 1 AND 2
CONTRACTS - TOTAL
DUAL CONTRACTS (EXCLUSIVE OF WORK DONE PRIOR TO MARCH 19, 1913)
DUAL
Per Cent. Ages
DOLLARS
DUAL CONTRACTS TOTAL VALUE OF WORK
DUAL CONTRACTS VALUE OF WORK DONE AFTER MARCH 19, 1913
DUAL CONTRACTS 1 AND 2 TOTAL VALUE OF WORK
Dollars in Millions
Years from Signing of Contract

VALUE OF LABOR AND MATERIALS ONLY - CITY-OWNED LINES

FIG. 6. VALUE OF WORK DONE, COMPARED FOR OLD AND NEW LINES

The figures given for city-owned lines operated by the New York Municipal Railway Corporation, as shown in the left-hand group, include the mileage across the Williamsburgh and Manhattan bridges and also the mileage in the Centre St. Loop and portions of the Fourth Ave. subway in Brooklyn which were under contract for construction when the dual contracts were signed. If these mileages are eliminated the totals and corresponding percentages are as given in the right-hand group.

FIG. 7. MAP OF OLD SUBWAY (CONTRACTS NOS. 1 AND 2) WITH DATES OF OPERATION

In other words, of all the track to be constructed under the dual contracts, 70% is now in operation. The situation may be visualized by reference to the map of the dual system, Fig. 8.

On June 22, 1915, two years and three months after the dual contracts were signed, five miles of track, for which construction contracts were let during this period, were put in operation. From that date to the present time additional tracks have been put in operation at a fairly uniform rate, as shown especially in the diagram, Fig. 5.

Construction of the city's old subway, with 73 miles of track, extended over a period of more than eight years, but the formal opening was on Oct. 27, 1904, 4¾ years after the contracts were signed. Inauguration of the "H" operation on the Interborough system, which may be considered the formal opening under the dual contracts, occurred Aug. 1, 1918, 5¼ years after the contracts were signed. That this opening was materially delayed by war conditions is beyond question and without doubt under normal conditions could have been advanced at least six months. It is therefore fair to compare the progress under contracts Nos. 1 and 2 for the 4¾-year period with the progress under the dual contracts for the 5¼-year period.

On Oct. 27, 1904, 34 miles of track were put in operation, approximately 46% of the entire project. On Aug. 1, 1918, 135 miles of track on city-owned lines alone (excluding the East River bridges and the portions of the Fourth Ave. subway and Centre St. loop which had been contracted for prior to the signing of the dual contracts) and about 71 miles of company-owned lines, or a total of 206 miles of track, had been put in operation. In percentages of total, 58% of city-owned lines, 72% of company-owned lines, or 62% on all lines, was in operation.

As a large section of track on contract No. 1 was put in operation soon after the opening, it might be fairer to compare these dual contract figures with the track in operation on contracts Nos. 1 and 2 two months

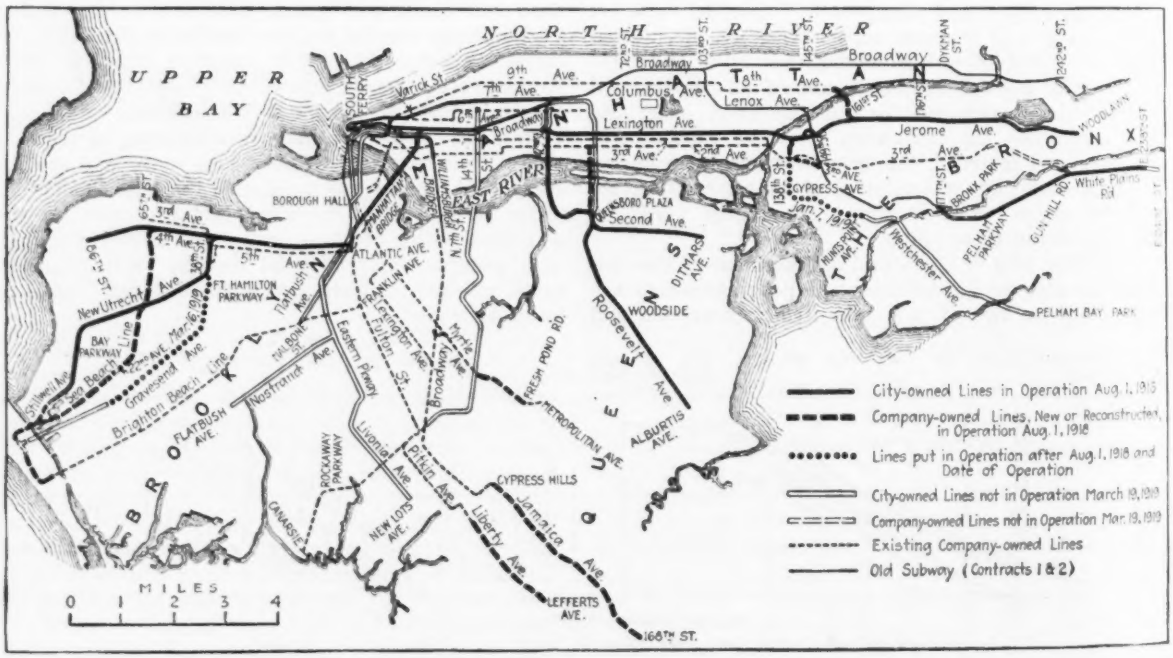


FIG. 8. NEW SUBWAY AND ELEVATED LINES, AND COMPLETED SYSTEM

after the formal opening, when 50 miles of track had been put in operation, or 68% of the total. More than four times as much track under the dual contracts was in operation as on contracts Nos. 1 and 2 for a corresponding period (although the percentage of the total was slightly less). A comparison of the maps showing the old and new systems (Figs. 7 and 8) will help to visualize the relative sizes of the undertakings and the relative progress in getting them in operation.

On Dec. 31, 1918, approximately $185,000,000 had been expended for labor and materials on city-owned lines under the dual contracts, or approximately 84% of the estimated total. On Dec. 31, 1905, the corresponding expenditures under contracts Nos. 1 and 2 had been $42,000,000, or approximately 83% of the total cost. In point of cost, therefore, the work on the old subway was only 23% as large as the work done in a corresponding period under the dual contracts.

Work Done Rapidly—A general impression has been current that the work under the dual contracts has lagged. From whatever angle it is viewed, it is evident from the data herein given that this has not been the case, and that, in fact, extraordinary progress has been made. The progress on contracts Nos. 1 and 2, constructed in normal times and with wide-open street excavations, was considered eminently satisfactory at the time (1900 to 1906), and the initial opening in 1904 was hailed as the accomplishment of a wonderful achievement. *Yet five times as much has been completed on the dual contracts project* in an equal period of time, and this during war, and with all excavations carried on under street decking, thereby greatly increasing the difficulty of the work and retarding progress. Although this new system is five times as large as the first subway enterprise, it has advanced at practically the same rate in percentage of the whole.

In summary, today, after six years, it is 95% under contract, 86% completed and 70% actually in operation.

Fundamentals in the Make-Up of a Concrete Mixture

Thirteen Points Offered by A. N. Talbot Governing the Physical Conditions Which Affect Concrete Making

CLEAR thinking on the subject of concrete as a material will be helped by a study of the remarks made by Prof. A. N. Talbot of the University of Illinois at the recent annual convention of the American Railway Engineering Association. In discussing the report of the committee on masonry, Professor Talbot said in part:

Recently I talked with two engineers concerning improvements in making and placing concrete. Both agreed that changes in procedure might be made with advantage. One described a method which he favored, but said it required an artist to carry it out. The other criticised a proposed specification and said it was "only more of this artists' stuff." I have no doubt there are many who feel that much of what is proposed for the improvement of concrete is unnecessary and impractical — mere "artists' stuff." Familiarity with mixing and placing concrete is likely to breed contempt for rules and regulations, especially when the ill effects of the disregard of proper precautions and workmanlike methods are not apparent to those doing the work. Discussions on how to produce good concrete must add to our information, help to make us better workmen and to secure much better concrete.

Concrete is a complex product. Many elements enter into the development of its strength. As it is well to have some idea of the physical conditions which affect concrete in its making, I have jotted down a number of items which seem to me to bear on the effect of the make-up of the mixture; these are offered as suggestive of the way in which the amount of water used in mixing and the gradation or variation of size of the particles making up the combination of fine and coarse aggregate may be expected to influence the strength of the concrete. These statements may seem elementary; in many respects they are crude. They are presented, however, with the thought that even a general conception of the physical conditions will be helpful in understanding the effect of changes in amount of mixing water and of variations in the size of the fine and coarse aggregate. It is to be understood that there are limitations and qualifications that will not be expressed here. Here are the items:

1. The cement and the mixing water may be considered together to form a paste; this paste becomes the glue which holds the particles of aggregate together.

2. The volume of the paste is approximately equal to the sum of the volume of the particles of the cement and the volume of the mixing water.

3. The strength given by this paste is dependent upon its concentration—the more dilute the paste, the lower its strength; the less dilute, the greater its strength.

4. The paste coats or covers the particles of aggregate partially or wholly and also goes to fill the voids of the aggregate partially or wholly. Full coating of the surface and complete filling of the voids are not usually obtained.

5. The coating or layer of paste over the particles forms the lubricating material which makes the mass workable; that is, makes it mobile and easily placed to fill a space compactly.

6. The requisite mobility or plasticity is obtained only when there is sufficient paste to give a thickness of film or layer of paste over the surface of the particles of aggregate and between the particles sufficient to lubricate these particles.

7. Increase in mobility may be obtained by increasing the thickness of the layer of paste; this may be accomplished either by adding water (resulting in a weaker paste) or by adding cement up to a certain point (resulting in a stronger paste).

8. Factors contributing to the strength of concrete are, then, the amount of cement, the amount of mixing water, the amount of voids in the combination of fine and coarse aggregate, and the area of surface of the aggregate.

9. For a given kind of aggregate the strength of the concrete is largely dependent upon the strength of the cement paste used in the mix, which forms the gluing material between the particles of aggregate.

10. For the same amount of cement and same voids in the aggregate, that aggregate (or combination of fine and coarse aggregates) will give the higher strength which has the smaller total area of surface of particles, since it will require the less amount of paste to produce the requisite mobility and this amount of paste will be secured with a smaller quantity of water; this paste, being less dilute, will therefore be stronger. The relative surface area of different aggregates or combination of aggregates may readily be obtained by means of a surface modulus calculated from the screen analysis of the aggregate.

11. For the same amount of cement and the same surface of aggregate, that aggregate will give the higher strength which has the less voids, since additional pore space will require a larger quantity of paste and therefore more dilute paste.

12. Any element which carries with it a dilution of the cement paste may in general be expected to weaken the concrete. Smaller amounts of cement, the use of additional mixing water to secure increased mobility in the mass, increased surface of aggregate, and increased voids

in the aggregate all operate to lower the strength of the product.

13. In varying the gradation of aggregate a point will be reached, however, when the advantages in the reduction of surface of particles is offset by increased difficulty in securing a mobile mass, the voids are greatly increased, the mix is not workable, and less strength is developed in the concrete. For a given aggregate and a given amount of cement, a decrease in the amount of mixing water below that necessary to produce sufficient paste to occupy most of the voids and provide the lubricating layer will give a mix deficient in mobility and lower in strength.

A certain degree of mobility is necessary in order to place concrete in the forms in a compact and solid mass, the degree varying considerably with the nature of the work, and generally it will be found necessary to sacrifice strength to secure the requisite mobility. It is readily seen, however, that the effort should be made to produce as strong a cementing layer of paste as practicable by selecting the proper mixture of aggregate and by regulating the amount of mixing water.

More thorough mixing not only mixes the paste and better coats the particles, but it makes the mass mobile with a smaller percentage of mixing water, and this less dilute paste results in higher strength. Any improvement in method of mixing which increases the mobility of the mass will permit the use of less dilute paste and thereby secure increased strength.

Cost of Highway Concrete Delivered Wet by Trucks

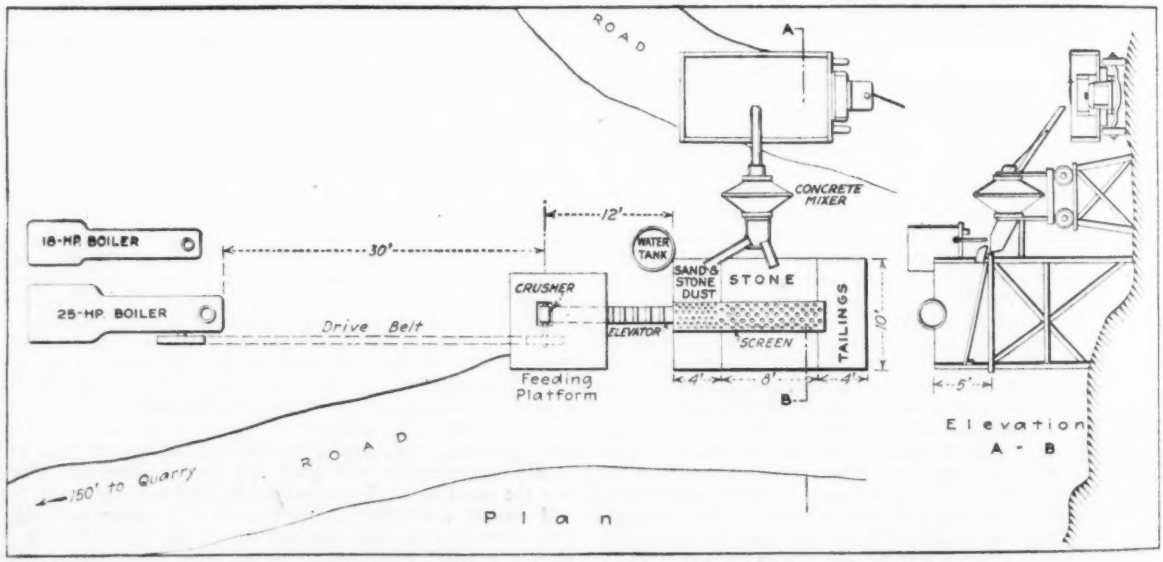
Central Crushing and Mixing Plant Set Up at Quarry — Concrete Aggregate from Crusher Bin Run Directly Into Mixer and Thence Into Trucks

DELIVERY of wet concrete, from a central crushing and mixing plant, to the road surface, by motor trucks, over hauls ranging from ¼ mile to four miles, is being satisfactorily accomplished on the Belair Road of the Maryland State Road Commission. By this method extensive rehandling of materials is dispensed with, thus reducing the cost, and the speed of the trucks is such that for the distances named there is no apparent injury to the quality of the concrete mixture. The maximum time required to transport the concrete from the mixer to the road is 35 minutes.

Most of the roads built by the State Road Commission in the past have been of the waterbound-macadam type. These have since received a surface treatment or have been covered with bituminous macadam. Recently the surfaces of the roads have shown signs of failure where subjected to heavy traffic, such as has been common during the past two years, due to heavy motor-truck freight routes.

While there has been some wearing of the central part of the road, most of the failure has occurred near the edges, accompanied in most cases by a spreading of the road crust. The conditions led to two conclusions: (1) That the roads are too narrow, and (2) that support is needed at the edges to overcome the spreading action of the traffic.

The design finally decided upon to overcome these difficulties was adopted for the Baltimore-Washington Boulevard and was described in *Engineering News-Record* of Nov. 28, 1918, p. 990. It provides for the laying of a 3-ft. strip of concrete 8 in. thick on each side of the macadam road, and connecting it with the old road with new macadam. One of the illustrations shows a stretch of the Belair Road of this design, with one shoulder completed and connected with the old road. After both shoulders are completed, the entire road receives a seal coat of bituminous material and stone chips, which is allowed to cover the concrete shoulder, giving a pavement 20 ft. wide of uniform appearance, as shown in an illustration.



LAYOUT AT CENTRAL CRUSHING AND MIXING PLANT FOR HIGHWAY CONCRETE

As there was excellent stone in most of the hills adjacent to the road, the contractor decided to save handling labor by mixing the concrete at the quarry and hauling it to the road in motor trucks. A location about midway of the contract was selected, a quarry was opened and a crushing and mixing plant was set up.

The general arrangements at the plant are shown in the accompanying sketch. Two portable boilers of the locomotive type were used; one, a 25-hp. boiler and engine, furnished power to run the crusher and mixer, the other, an 18-hp. boiler, furnished steam for the rock drills at the quarry and for pumping the necessary water for the boilers and the concrete.

A jaw crusher was placed under the platform upon which the stone from the quarry was dumped. After being crushed, the stone is elevated into the bin and separated into the desired sizes by a rotary screen.

ONE SHOULDER COMPLETED AND CONNECTION MADE WITH OLD BITUMINOUS ROAD

There are three general sizes of stone: The chips which pass a ¾-in. screen go into the sand bins; the crushed rock passing a 2½-in. screen goes into the coarse aggregate bin, while the larger stone goes out as tailings. What tailings cannot be used for repairs on the construction road are taken out and again fed through the crusher. As the crusher does not produce enough fine material, sand is also delivered upon the platform and fed through with the stone and elevated into the sand bin.

Gravity is utilized to the utmost throughout the operations, from the quarry to the mixed product in the truck body. The plant is situated at the foot of a hill down which the quarried rock is hauled in carts to the crusher platform. After crushing, the stone and sand are fed directly into the mixer from the bins, care being taken to proportion them properly. Water is supplied from the elevated tank shown in the sketch. The bin and the platform for the concrete mixer are placed at such height that the mixer can discharge directly into the trucks.

On the road the dumping of the concrete follows a different plan than would be employed if the entire road section were being covered, as in the case of constructing a concrete road. As the shoulder which is being constructed is of small section, it is necessary to dump the mixed concrete upon the surface of the old road and shovel it into the forms on the side. One truck load of concrete fills about 35 ft. of forms, and extra handling is necessary, which of course increases the cost above what it would be if an entire road surface were being built.

Convict labor is utilized for common labor upon this road, a camp being built at the quarry to house and feed the laborers. Guards are provided by the prison officials for watching the convicts, but the contractor furnishes the foremen to supervise the work. The contractor reports that this labor is quite satisfactory. In the construction of the shoulders steel forms are used, and the finishing is done as described in the article published in *Engineering News-Record* of Nov. 28, 1918.

Approximate costs for carrying work on under this

ITEMIZED COST OF LAYING THREE-FOOT CONCRETE SHOULDERS FOR MACADAM ROADS

Quarrying and Crushing Stone per Day	
1 foreman at 65c. per hour	$5.85
1 engineer at 44 4/9 c. per hour	4.00
1 blacksmith at 44 4/9c. per hour	4.00
17 laborers at 27 7/9c. per hour	42.50
3 carts at 55 5/9c. per hour	15.00
Equipment at $7.50 per day	7.50
25 lb. dynamite at 30c. per pound	7.50
Total cost per day for 36 cubic yards of stone and 4.4 cubic yards of dust	$86.35
Cost of rock per cubic yard in quarry	$2.137
Royalty	.15
Total cost rock per cubic yard	2.287
Sand per Day	
Sand in pit, 13.6 cubic yard at 85c. per cubic yard	$11.56
Hauling sand and cement by truck, $30 per day	30.00
Three laborers at 27 7/9c. per hour	7.50
Total cost per day	$49.06
Total cost per cubic yard	$3.61
Mixing Concrete per Day	
3 men at 27 7/9c. per hour	$7.50
Equipment $7.50 per day	7.50
Total cost per day for 40 cubic yards	$15.00
Total cost per cubic yard	.375
Hauling Concrete to Road per Day	
1 truck at $18.00 per day	$18.00
1 truck at 25.00 per day	25.00
1 truck at 27.50 per day	27.50
Total cost per day for 40 cubic yards	$70.50
Total cost per cubic yard	$1.762
Placing Concrete per Day	
1 foreman at 55 5/9c. per hour	$5.00
2 laborers, build forms 27 7/9c. per hour	5.00
Placing, 4 laborers at 27 7/9c. per hour	10.00
Total cost per day for 40 cubic yards	$20.00
Total cost per cubic yard	.50
Cost of Concrete in Place per Square Yard	
Cement, 1.5 bbl. at $2.50	$3.750
Sand, 0.34 cubic yard at $3.60	1.227
Dust, 0.11 cubic yard at $2.287	.252
Stone, 0.9 cubic yard at $2.287	2.058
Mixing, per cubic yard	.375
Hauling, per cubic yard	1.762
Placing, per cubic yard	.500
Total cost per cubic yard	$9.924
Total cost per square yard, 8 in. thick	2.205
Grading per Square Yard	
1 foreman at 55 5/9c per hour	$5.00
8 laborers at 27 7/9c per hour	20.00
Total for 180 sq.yd	$25.00
Cost per square yard	$0.138
Total cost per square yard	2.343

Approximate costs for carrying work on under this

COMPLETED ROAD HAS UNIFORM APPEARANCE

system are given in the accompanying table, the basis used being an average haul of 3½ miles for 6975 ft. of shoulder laid in a period of 13 working days. The average day's work was thus 535 lin.ft. or 179 square yards.

Quarrying and crushing the rock cost about $2.29 per cubic yard, while the mixing was about 38c. per cubic yard. Sand cost $3.61 per cubic yard and the hauling for the average haul was $1.76 per cubic yard. The total cost of the concrete shoulders, including the grading, was about $2.34 per square yard. These costs include interest on investment and depreciation of equipment.

No figures are available as to the cost of connecting up the concrete shoulder with the old surface, this depending largely on the amount which it was necessary to excavate, due to the ravelled condition along the edge. In all probability, this would be about the same as patching with this material.

Comparison of the relative cost of laying shoulders by hauling the wet concrete as against that of distributing the materials on the road and mixing at the site shows on the Maryland work a considerable saving in favor of the former method. The table shows that the cost per square yard by the wet-hauling method was $2.34 for the section for which costs are given, while the cost upon the Baltimore-Washington Boulevard constructed by the other method was $3.24 per square yard.

The large saving was in handling materials. Mixing, placing, forms, curing and protection on the boulevard cost 84c. per square yard, while the same operation on the Belair Road cost about 20c. per square yard. The average haul for the entire road is about 2½ miles, and the costs given were taken for an average haul of 3½ miles. This would also decrease the average cost per square yard in place for the entire road.

The work on the Belair Road is being done by the Maryland State Roads Commission, of which Frank H. Zouck is chairman, and J. N. Mackall is chief engineer. Edwin Friese is resident engineer for the commission, and the American Paving and Contracting Co., of Baltimore, is the contractor for the work.

Factors Governing Selection of Industrial Site

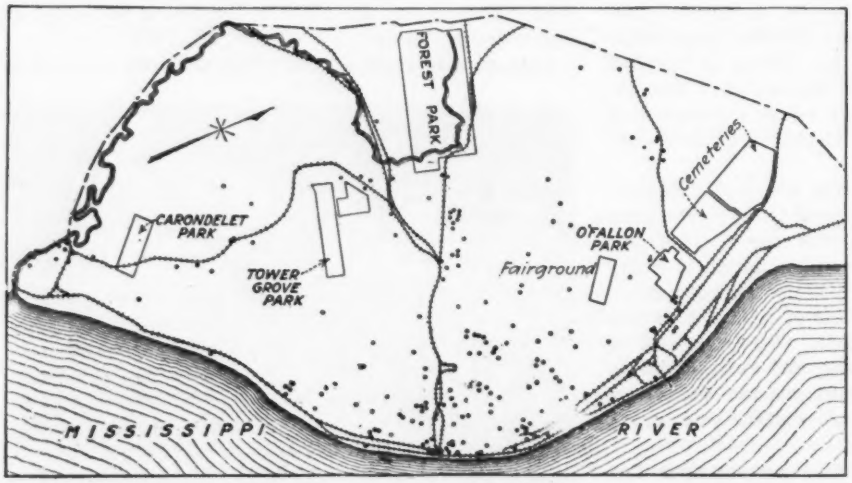
Railroad Facilities and Land Values Have Little Effect on Choice—Motor Trucks Supply Transportation Needs

By Harland Bartholomew
Engineer, City Plan Commission, St. Louis, Mo.

THAT the location of industrial plants appears to depend less upon direct railroad connections than is generally supposed is indicated by maps and figures prepared in connection with the St. Louis zone plan. Studies of the location of all industries in the city show that probably 50% have no direct railroad facilities and are more or less removed from what are generally termed industrial districts. In fact, there is increasing evidence that the motor truck is meeting transportation needs.

Many other considerations such as prevailing prices of land for industrial purposes, source of labor supply, local transit facilities, switching charges, water-supply, character of industry, etc., enter into the matter of locating industrial plants. However, knowledge of local conditions in St. Louis indicates that a relatively small number of plants have selected their sites solely from the standpoint of low land value. This being the case, the necessity of regulating the location of industries in the interest of sustaining land values is readily seen.

Among the maps mentioned above, there is one showing the distribution of new industrial plants located in St. Louis during the five years from 1913 to 1917. This map, which graphically illustrates the conditions as stated, is reproduced herewith. Only plants having a structural cost of $5000 or more were considered—warehouses, power plants, additions to existing factories, etc., being excluded. Of 170 such plants, 106, or 62½%, did not have direct railroad connections. The map shows that the majority of these were located in the central eastern section of the city, which is already largely built up. In other words, they disregard land values in favor of proximity to labor supply, inasmuch as the densest population is in the central eastern part of the city. One concern which manufactures a line of commercial electric specialties and employs several hundred operatives, including many women, recently erected a plant just west of Grand Ave., an important business street, this being the first large factory to invade this residential section. The location was chosen in preference to several other less expensive sites considered because it offered better surroundings than the usual industrial district, making it attractive to women workers, and because it was adjacent to the car line which



DISTRIBUTION OF NEW INDUSTRIAL PLANTS LOCATED IN ST. LOUIS FROM 1913 TO 1917 WITH RESPECT TO RAILROADS

gave quickest access to all residential sections. These considerations, in the opinion of the owner, were more important than direct railroad connections or a less expensive site. In other words, the owner figured that the extra cost of land and of transporting his product to the railroads by motor truck was more than offset by the advantageous labor conditions to be obtained. And the conclusions of this manufacturer seem to be typical of those of the majority.

Congestion of railroad terminals in large cities has caused shippers to depend more and more upon the motor truck for short-haul traffic, either for direct delivery to the consignee or to the railroad. One of the largest shippers in an Eastern city, though located on a railroad, found it cheaper to carry all of his freight by motor truck to the terminal of another railroad, a distance of three or four miles, than to load the freight upon railroad cars at his plant and wait for them to be switched to the railroad over which they were to go. In this particular city there exists no belt-line or connecting railroad, and switching charges may be unusually high, but it is a well known fact that the terminals of the railroads in most large cities are being taxed to their capacity, and shippers undoubtedly are finding the motor truck a time saver as well as a money saver.

One of the limiting factors in the capacity of a railroad terminal or of a railroad itself is the number of tracks that exist or that can be built and maintained economically. Certainly, no terminal or railroad can provide as many tracks as there are streets in a city. If the streets are well planned and well paved, so that transportation by motor truck is unimpeded, the transportation problem is greatly simplified, the burden on the railroad terminals is reduced and the capacity of the railroads for through traffic increased.

Regulation of the location of industries in the interest of the welfare of the city is therefore necessary. To permit industries to invade residential districts, especially just now when labor supply is a large factor, would be to invite economic disaster, since no residential district would long maintain its values under such conditions. If invasion of residential districts is allowed to proceed without abatement, the city becomes the loser in taxes, while new residential districts farther away from the city's center are built, and the cost of providing additional utilities, such as water, transit, pavements, lighting, etc., must be met in greater or less part from the city's treasury. To establish certain well defined industrial districts, on the other hand, should prove advantageous, since an intensive development would permit cheaper services, such as power from a centralized station or stations; and the presence of such a district, with its large opportunities for employment, would tend to attract a more or less adequate supply of labor to the adjoining residential districts.

Cities as well as manufacturers must give more than casual thought to the communal problems of industry. When these are properly solved, there is much more economic value in the solution for both the city and the manufacturer, than in many of the wasteful, haphazard methods of the past. Here is a reconstruction measure worthy of serious consideration.

Line Revision on Cincinnati Southern Railroad

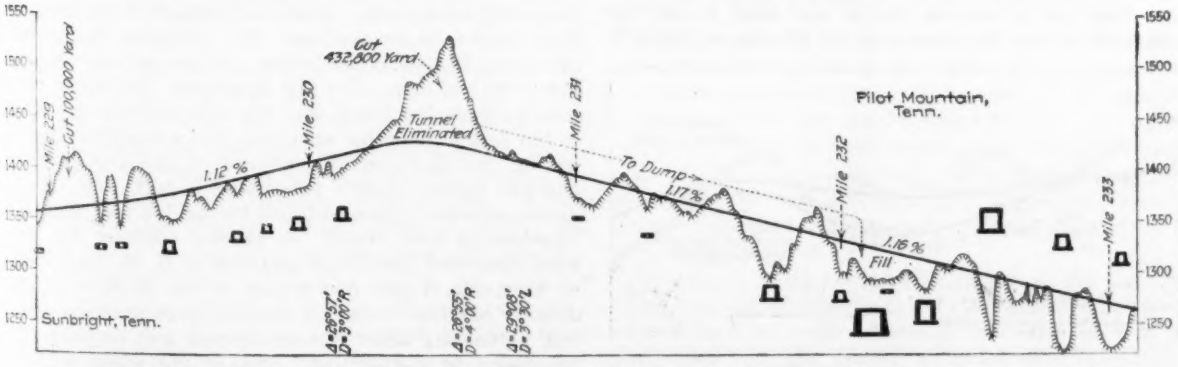
Heavy Rock Cuts, but Few Bridges—Stream Diverted Through Old Tunnel to Avoid Crossings

SINGLE-TRACK and double-track relocations or cutoffs, to improve alignment and profile and to eliminate tunnels, are part of the improvements being made by the Southern Railroad Lines in the extension of double-tracking on the Cincinnati Southern line between Cincinnati, Ohio, and Chattanooga, Tenn. One of the abandoned tunnels will be utilized in stream diversion to avoid a double crossing. Heavy rock excavation, with long and deep cuts and fills, is a feature of the revision, the heaviest work being in mountain country between Helenwood and Lancing, Tenn.

A 4000-ft. stretch of line revision south of Helenwood eliminates two tunnels 364 ft. and 367 ft. in length, reduces curvature and brings the grade above flood level. The old line here followed the west bank of Phillips Creek, and was at such an elevation that after heavy storms the water occasionally rose over the tracks and flowed through the second tunnel, beyond which it returned to the natural channel. In the fall of 1917 such an occurrence caused interruption to traffic.

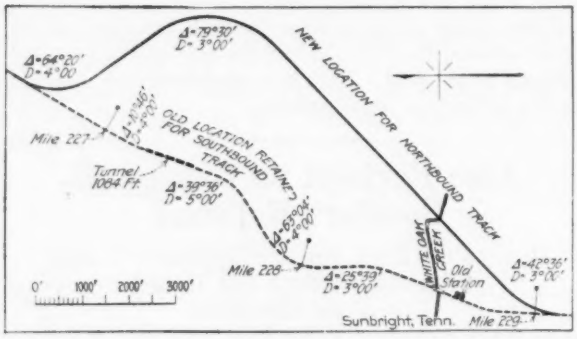
The new location here, as shown in one of the drawings, is on the east side of the creek, the line being straightened and put at an elevation of about 15 ft. above the old grade. To avoid two stream crossings on the relocation, a cut-off channel is excavated, thus eliminating a sharp bend of the creek. The second abandoned tunnel is utilized as part of this channel, its floor being lowered 6 or 8 ft. below the original grade.

Relocations requiring the heaviest construction on



TYPICAL HEAVY GRADING ON RELOCATION OF CINCINNATI SOUTHERN RAILROAD

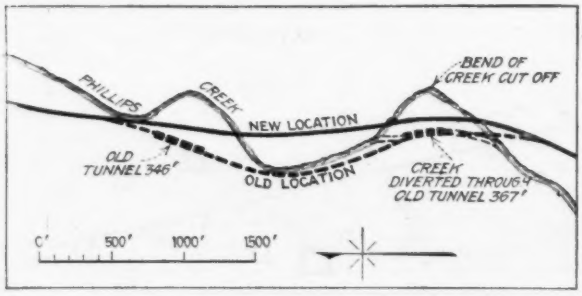
the whole of the present improvement are included on the 12-mile stretch between Huffman and Lancing. In the first place, there is a single-track cutoff for northbound traffic only, the old line being satisfactory for southbound trains. This is shown on one of the drawings. It is nearly three miles long and keeps about half a mile from the old line, avoiding one tunnel and several curves, besides giving a more favorable profile. Following this is a double-track revision for about 2½ miles, which closely parallels the old line, but is on the opposite side of the valley. This eliminates one tunnel and several curves of five and six degrees, but the old line here will be retained for use as a passing track. Two other revisions of about 2000 ft. each avoid tunnels 630 ft. and 403 ft. in length. Another tunnel only 204 ft. long will be eliminated by a double-track cut. Elimination of these old tunnels reduces the smoke nuisance and avoids difficulties due to the limited clearance for large modern equipment.



DOUBLE TRACKING AT SUNBRIGHT, TENN., HAS NEW LOCATION FOR SECOND TRACK

Long and deep cuts, having 90% of the excavation in hard sandstone, are encountered on these relocations; part of a typical profile on this section of the line is shown in an accompanying drawing. Although the work is along steep sidehill slopes, through cuts are generally required. The largest cut is about 435,000 yd., with a maximum depth of 100 ft. and a length of 2500 ft. Two others are of 200,000 yd. and 125,000 yd., both about 90 ft. deep and 900 ft. long.

Well drills are used to open up the cuts, with steam drills to finish them to shape and grade, and steam shovels to remove the material. Blasting is done mainly with 40% and 60% dynamite, in order to get quick and shattering action in the hard rock. Usually a narrow through cut is made first, the shovel then returning to the starting point to widen this along one side. At one deep cut a hoisting engine was used to get the steam shovel up the steep slope to the top of the hill, and this engine also operated the dump-car trains by cable on a steep incline. At another similar cut it was proposed to build a switchback track on the hillside, in order to obtain a grade enabling the dump-car trains to reach the steam shovel.

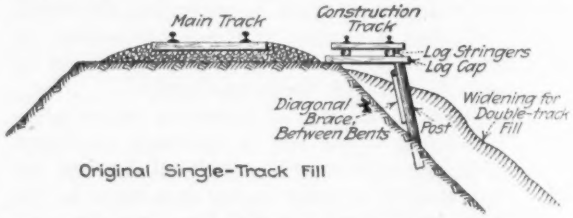


LINE REVISION INCLUDES DIVERSION OF CREEK THROUGH ABANDONED TUNNEL

Narrow-gage construction equipment was installed by the contractor on this section, using 8-yd. double-truck dump cars and four-wheel dinkey locomotives. With a haul of two or three miles, however, these dinkeys could not handle the work satisfactorily. In fact, the engineers considered a haul of 3000 to 4000 ft. the economic limit for such engines. The railway then handled this work with standard-gage 16-yd. cars and 50-ton locomotives. This equipment was not operated on the main track, however, as traffic conditions necessitated keeping the work trains almost exclusively on the construction tracks.

Temporary trestles of round timber were used for most of the fills. Peg-leg trestles were used mainly in starting to widen existing fills, thus carrying the construction track clear of main-line traffic. Each bent had a single batter post set in the old slope and supporting one end of a cap whose other end rested on the edge of the old fill. These bents were spaced about 12 ft. apart, carrying log stringers and being braced longitudinally by pole diagonals. The widening was then completed with the construction track on the new fill.

Structures of importance are relatively few on the new lines, partly because the roadbed is largely benched in solid ground and partly because the amount of excavation made it economical to form long and high fills with culverts to accommodate drainage. At Phillips Creek, where the grade necessitated a low and wide opening, the necessary waterway was obtained by a six-barreled concrete box culvert having rectangular openings 6 ft. wide and 12 ft. high.



PEG-LEG TRESTLE CARRIES TRACK FOR WIDENING FILLS

A five-span, single-track bridge with 100-ft. plate-girder spans on concrete piers 90 ft. high is the largest new structure. This has its center line 40 ft. from that of the old steel viaduct, which will remain in use for the northbound track. Solid rock, almost at the ground level, forms the foundations. For the piers the mixer plant was located at the bottom and served an elevator tower with chutes. For the abutments the mixer was placed beside the track, and the concrete was wheeled to the forms. Another structure was a concrete bridge having two 43-ft. spans composed of two side girders and two center girders supporting a deck slab. This design allowed building of half the bridge first without interference with traffic. A general contract for the work described above was awarded to H. H. Thrasher, of Knoxville, Tenn., and a part of the work is being done by company forces. Labor shortage has been serious, as floating labor is very limited, and negroes are not found in this section. Few of the white natives care for this kind of work, although they will work on

the section gangs. Camps with houses are provided at a few points, but as a rule the men live in boarding trains.

All construction work is under the direction of E. M. Durham, Jr., chief engineer of construction, Southern Railroad Lines. R. W. Jones, Jr., is district engineer, at Lexington, Ky., with P. R. Shields and R. H. Small as assistant engineers.

Rainfall, Absorption and Run-off on Small Rural Drainage Area

Study of Heavy Rain, Total Run-off With Soil Absorption and Run-off for Small Plats —The Hydraulic Jump

By Ivan E. Houk
Assistant Engineer, Miami Conservancy District, Dayton, Ohio

INTERESTING data on rainfall, soil absorption, and run-off were obtained on Moraine Farm, the home of Col. E. A. Deeds, during a flood that occurred in September, 1916.

Moraine Farm is situated among the hilly, glacial deposits, known as moraines, about five miles south of Dayton. The greater part of the farm, with some area to the south and east—amounting to about 2.6 square miles in all—is drained by a small creek having an average fall of about 100 ft. per mile in its total length of about two miles. The approximate natural slope of the ground over the drainage area varies from 1 to 20 ft. per 100, averaging 3 or 4 ft. About 7% of the surface is wooded. The surface soil, which is a clay loam, containing some sand and gravel, is underlain by comparatively thick glacial deposits of sand and gravel. Careful records of rainfall, run-off and soil absorption have been maintained on this watershed by the Morgan Engineering Co. and the Miami Conservancy District since March, 1915.

The observations and studies will later be published in detail in the "Technical Reports" of the Miami Conservancy District.

Rainfall Observations

The flood for which the data are here given occurred on Sept. 5. Although some rain fell over a considerable part of Ohio on that date, the precipitation did not seem to be unusually heavy, except in the Miami Valley.

At the Dayton coöperative Weather Bureau station the total for the 24 hours which ended about 10:30 a.m., Sept. 6, was 4.85 in. At the local office of the United States Weather Bureau, about two miles west of the former station, a total of 3.83 in. was recorded; and at Moraine Farm, about five miles south of the Weather Bureau office, the readings of the three gages maintained by the Miami Conservancy District were 4.09, 4.30, and 4.33 in. for the same period of time. Of the last three gages, the two reading 4.30 and 4.33 in. are within 100 ft. of each other and are about a quarter of a mile northwest of the one reading 4.09 in. At the local office of the United States Weather Bureau the maximum intensities, determined by the triple register, were 0.43 in. for 5 min., 0.79 in. for 10 min., and 1.75 in. for 30 minutes.

The periods and amounts of rainfall as shown by the same instrument were as follows:

P. M.	In.	P. M.	In.
3:03 to 4:00	0.97	7:00 to 8:00	0.99
4:00 to 4:41	0.89	8:00 to 9:00	0.05
4:57 to 6:00	0.47	9:00 to 9:40	0.01
6:00 to 7:00	0.13	Total	3.51

While the rain began at 3:03 p. m., as noted above, the heavy rain did not begin until 3:44 p. m. From 3:44 to 4:16, 1.75 in. fell; from 5:01 to 5:11, 0.32 in.; from 7:16 to 8:00 p.m., 0.96 in. About 0.27 in. fell in 10 minutes about 9 a. m. the following day.

The ground was comparatively dry when the rain began. There had been only a normal amount of rainfall during August, and this had been well distributed through the month. About 0.06 in. fell from Aug. 26 to 28, inclusive. There was no precipitation on Aug. 29, 30, or 31. On Sept. 1 about 0.33 in. fell. Then there was no more rain until Sept. 5.

The amounts of moisture in the soil in percentage of the dry weight were determined both before and after the heavy rainfall. Soil samples, weighing about 2 lb., were taken where the ground was nearly level, by digging with a spade. No attempt was made to secure an exact volume. The samples were carefully weighed on scales weighing to the nearest tenth of a gram, and were then dried in the furnace room at the farm and reweighed until their weight became constant.

The samples taken Aug. 28 and Sept. 6 showed the following percentages of moisture:

Depth Below Ground Surface, In.	Moisture Content, Per Cent 8-28-16	9-6-16	Remarks
6	3.1	15.1	Under cultivated cover
12	3.3	5.4	Under cultivated cover
18	4.1	6.8	Under cultivated cover
24	4.4	8.7	Under cultivated cover
6	8.0	13.9	Under sod cover
12	8.2	15.9	Under sod cover
18	10.3	15.3	Under sod cover
24	10.6	16.5	Under sod cover
Average	6.5	12.2	

These results show an average increase in moisture content of about 5.7%. Assuming the weight of 1 cu.ft. of earth in place to be 100 lb. when perfectly dry, 5.7% of moisture would correspond to about 1 in. of rain per foot of depth or to about 2 in. in the total depth in which the samples were taken. This amount does not represent the total absorption of the soil, however, since the material deeper than 2 ft. is almost entirely gravel, and the water could move downward at a comparatively rapid rate once it reached this stratum.

Run-Off from Small Plats

Measurements of the total run-off during the flood were obtained on four small plats, each 5 ft. square. Two of these were situated on the side of a hill within a few feet of the rain gage reading 4.30 in. The other two were situated on level ground close to the rain gage reading 4.33 in. In each case the surface covering in one of the plats was kept spaded up, in a cultivated condition; while the surface in the other consisted of a heavy bluegrass sod.

No run-off at all occurred in either of the plats in which the sod covering existed. The grass, which was from 3 to 6 in. long, held back the water so that it could soak into the ground. Considerable run-off occurred on the plats in which the surface was cultivated.

In the plat on the level ground the total amounted to more than 1.9 in., or over 44% of the rainfall. The can in which the run-off is caught was filled entirely full and some water ran over, the amount of which there was no way of determining. In the plat on the hillside the total run-off amounted to 1.66 in., or 37% of the rainfall—somewhat less than on the level ground, probably due to differences in cultivation.

The maximum rate of run-off from the total drainage area was determined from high-water marks and cross-sections taken a few days after the flood. The survey covered a length of about a half mile, where the creek had been diverted into an artificial ditch. This ditch was straight, and was lined with concrete through a length of about 1300 ft. Six cross-sections were taken, three of the concrete-lined channel and three of the earth channel. In calculating the discharge, corrections in slope were made to allow for changes in velocity, and the parts of the cross-sections occupied by trees, in the earth channel, were omitted. Kutter's formula was used, taking a value of n of 0.015 for the concrete channel and of 0.045 for the earth sections.

The computations gave an average maximum rate of run-off of 900 sec.-ft., or 346 sec.-ft. per square mile. This is equivalent to a rate of run-off of about 0.54 in. per hour.

The Hydraulic Jump

An interesting hydraulic jump of about 2 ft. occurred at the lower end of the concrete-lined channel. Following the notation used by Professor Woodward (Miami Conservancy District, "Technical Reports," Part III, "Theory of the Hydraulic Jump and Backwater Curves," by S. M. Woodward) the conditions of flow were as shown in the table at the head of the next column.

Immediately below the end of the concrete channel, before the jump occurred, the actual depth was 2.55 ft., the neutral depth was 3.80 ft. and the critical depth was 3.41 ft.; that is y was less than y_c and y_c was less than y_n. These conditions correspond to Professor Woodward's Case C. According to his theory, then, the surface, on leaving the concrete channel, would slope upward until the depth became equal to the critical depth, the curve approaching a condition of verticality as y approached y_c; and then, since there is no curve by which the water can flow smoothly with the depth increasing from y_c to y_n, the increase in depth, which had to be made since the water could not flow through the earth channel at a depth equal to y_c, must be made by the transformation known as the hydraulic jump.

While the high-water marks obtained were not sufficiently accurate or in sufficient number to show the curvature of the surface in the different sections of the channel, they showed definitely that a rise in water surface of about 2 ft. did occur abruptly as soon as the water entered the earth channel, this rise taking place within a length of 50 feet.

CONDITIONS OF FLOW IN CONCRETE-LINED CHANNEL.

	Average Condition	
	In Concrete Channel	In Earth Channel
Actual depth y	3.04	4.30
Neutral depth y_n	2.96	3.80
Critical depth y_c	4.07	3.41
Surface curve	Case E	Case A

Progressive Erosion in a Dredged Drainage Channel

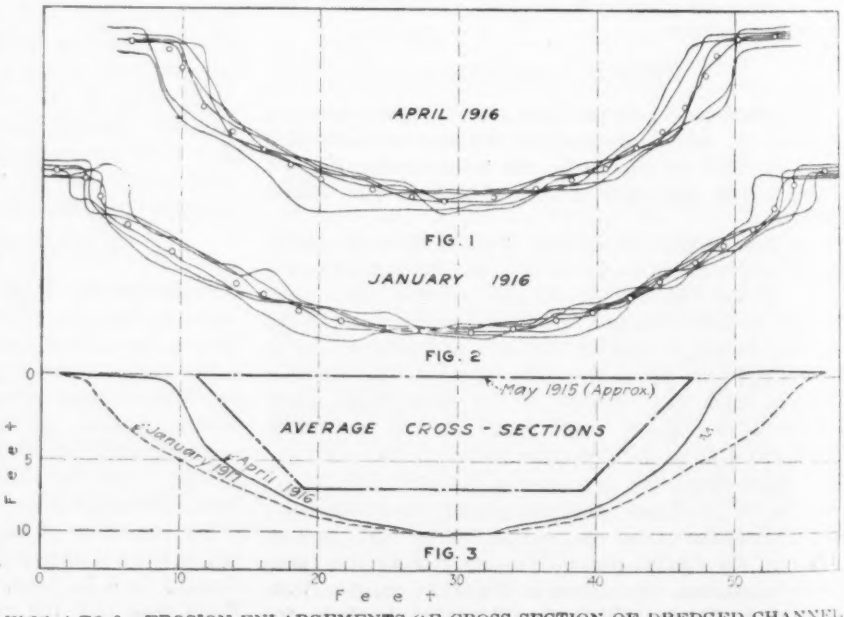
Observations on Enlargement and Effect on Capacity, Together With Computations of Value of n in Kutter's Formula

By C. E. Ramser

Senior Drainage Engineer, Office of Public Roads and Rural Engineering, United States Department of Agriculture, Washington, D. C.

It is generally known that drainage channels enlarge under certain conditions of soil and slope, due to the erosive action of the moving water. Very little information has been obtained to show the rate and amount of the enlargement, or the effect of the enlargement upon the capacity of the channel. To obtain definite data on this subject, measurements of the cross-sectional areas and computations of the values of n in Kutter's formula were made on the North Forked Deer River drainage channel, near Trenton, Tenn.

The portion of the channel selected for observation was constructed in May, 1915. Measurements of six cross-sections of the channel along a course of 700 ft. were made in April, 1916, and again in January, 1917. The hydraulic gradient and the discharge of the channel were also measured for use in the computation of values of n.



FIGS. 1 TO 3. EROSION ENLARGEMENTS OF CROSS-SECTION OF DREDGED CHANNEL OF NORTH FORKED DEER RIVER, TENNESSEE, FROM APRIL, 1916, TO JANUARY, 1917

Figs. 1 and 2 show the cross-sections of the channel in April, 1916, and May, 1917. The platted points represent the average of the six cross-sections. A comparison of these figures shows in this particular instance that, after a certain amount of erosion had taken place in a dredged channel erosion does not tend to increase the irregularity of the channel.

The average cross-sections represented by the platted points in Figs. 1 and 2 are platted together in Fig. 3. It is apparent from this figure that very little increase in the depth of the channel occurred after April, 1916, and that the greatest amount of enlargement occurred near the top of the channel on both sides. The original cross-section of the channel at the time of construction, May, 1915, is also drawn in Fig. 3 according to the specified dimensions as given in the engineer's report. It is likely that the channel was dug somewhat deeper than these dimensions show, but some increase in depth of channel occurred since construction, due no doubt to a natural adjustment of the bottom slope along the channel.

As given in the report of the engineer, the channel was designed for a slope of 0.0007, or a fall of about 3.6 ft. per mile. The maximum slope of the water surface as actually measured was found to be 0.00052, or about 2.75 ft. per mile.

Figs. 4, 5 and 6 are views of the channel taken during April, 1916, November, 1916, and January, 1917. Figs. 4 and 6 were taken looking downstream along the course of the channel where the cross-sectional measurements were made. Fig. 5 was taken just below the course but is, however, representative of the condition of the channel along the course. The caving of the banks as shown in Fig. 5 occurred during the fall season after the last high-water stage, some time in July. The first high stage that occurred at the end of this low-water period washed away all of the loose earth in the channel and left the channel clean and fairly smooth, as shown in Fig. 6. The soil in the channel varies in character from a silty loam at the top to a heavy, silty clay at the bottom.

Between April, 1916, and January, 1917, the average cross-sectional area of the channel increased from 331 to 409 sq.ft. The values of n in Kutter's formula obtained for high stage during the years of 1916 and 1917 were 0.0271 and 0.0267, respectively, from which it is seen that the roughness coefficient was practically the same before and after the erosion occurred. Using these values of n, the average cross-sectional areas and a slope of 0.0005, the capacities of the channel for these two sets of values were computed by Kutter's and Chezy's formulas and are given in the following table:

Date	Cross-Sectional Area, Sq.Ft.	Hydraulic Radius, Ft.	n	c	Mean Velocity, Sec.-Ft.	Discharge, Sec.-Ft.
April, 1916	331	6.69	0.0271	77.0	4.45	1,473
January, 1917	409	6.93	0.0267	78.3	4.60	1,881

From the table it is seen that the mean velocities in the channel were about 4½ ft. per second, and that the discharge capacities for 1916 and 1917 were 1473 and 1881 sec.-ft., which represents an increase of 27.7% for the period from April, 1916, to January, 1917. The increase in cross-sectional area was 23.5%, which is less than the percentage of increase in capacity.

The engineer who designed this drainage channel foresaw the probable effect of erosion, and accordingly did not attempt to provide for a rate of run-off that would give satisfactory drainage at the start. A considerable financial saving was thereby effected. The bottom lands benefited by this channel are now very satisfactorily drained, and in the meantime much of the land was being made ready for cultivation.

FIGS. 4 TO 6. REPRESENTATIVE VIEWS TO SHOW EFFECT OF EROSION ON DREDGED RIVER CHANNEL

Some of the factors that were favorable to the erosion of this channel and to the absence of silting were a straight alignment, a good slope with resulting high velocity in the channel, soil susceptible to erosion, the absence of retardation in velocity due to backwater, and only very little vegetation in the channel. Special attention is called to these factors to avoid the possibility of a general inference being made that all drainage channels enlarge due to erosion. On the other hand, the conditions may be such that practically no erosion takes place and, instead, silting or filling up of the channel occurs. For instance, erosion is often prevented or its progress checked by the growth of vegetation in channels, which growth in turn often promotes the rapid silting of channels. Cross-sectional measurements of a large number of drainage ditches, where the conditions affecting erosion have been quite varied, have been made by the Bureau of Public Roads and Rural Engineering for the purpose of obtaining reliable data on silting and erosion. Reports on these investigations will be prepared and then can be obtained from the bureau.

Vault Will Hold Two Freight Cars

To foil thieves who make a practice of stealing raw silk from freight cars—a very common practice—the Cheney Bros. silk firm at South Manchester, Mass., is building a vault big enough to hold two freight cars. The structure is 90 x 16 ft. in plan, with brick walls, a concrete roof and regulation vault doors at either end. The builder is the Aberthaw Construction Co.

Defects in Surface of Bituminous Pavement Due to Concrete Base

Data Collected at Oak Park, Ill., Indicate That Cracks and Other Objectionable Features Are a Minimum Where Flexible Foundations Are Used

By H. W. Skidmore
Construction Engineer, Department of Public Works, Oak Park, Ill.

PRACTICALLY all the defects in bituminous pavement, as now constructed in Oak Park, Ill., may be traced to the concrete base. Investigations by the engineering department show that these defects are greatly reduced where flexible foundations, such as macadam, have been used. This has led to the conclusion that homogeneity and a certain amount of resiliency are far more valuable in bases for such pavements than rigidity. The question arises as to whether bituminous concrete bases, which have been employed with great success in many cities, should not be substituted for the rigid form. Whichever type is used, good drainage is essential, as cement concrete has failed to bridge over weak subgrades.

Much has been said recently regarding changes in design of bituminous pavements, and observation of the action of these pavements has led many engineers to consider these changes seriously. For years the presence of cracks in pavements has been treated lightly by engineers with the statement that, as a rule, cracks are not a serious defect; but now the cracks seem to be receiving considerable attention, and efforts are being made to minimize or prevent them. In all these discussions there has been a significant lack of actual data. Just what effect cracks, depressions due to failure of base, upheavals, etc., have on the life of the pavement, and the cause of these defects, with the remedies therefor, are still matters of conjecture, and there are about as many different answers as there are engineers giving the problem thought.

With the idea of collecting accurate data the writer decided during the winter of 1916-17 to start an investigation. Plans were made for conducting a thorough inspection about twice a year. The kind of information needed was determined, and forms for recording such data were devised.

Inspections are made in the early spring and in the hot summer weather, the latter to determine the tendency toward hot weather cracking and the extent to which the subgrade retains moisture throughout the year. At first, the data obtained in the field and the subsequent deductions were tabulated on one large tracing which contained the record of all pavements. After making an analysis of the information obtained in our first inspection, it was decided that an individual record of each job would prove more satisfactory. A sample of the forms now used for record is shown herewith. These cards are easily filed and may be sorted and arranged, so that any specific set of figures may be taken off easily. Such data as may not be tabulated in columns by means of numbers are included in the "remarks."

In connection with these files we also have a complete card index of all pavement repairs which have been made during the writer's connection with the department. This record includes repairs made from 1914 to date. No record was kept prior to that year; consequently, analyses are somewhat imperfect so far as the older pavements are concerned.

As soon as the 1918 inspection was completed, summaries were made of the results. These summaries include various groupings of pavement, and also consider the various groups in relation to one another on the basis of length of service, the kind of asphaltic cement used in the wearing course, contractors, etc. The table given groups the pavements as to the type of consruction, and analyzes them with reference to the kind of asphaltic cement used and the age.

A comparison with relation to the kind and character of the subgrade was desired, but this could not be made, comprehensively, owing to a lack of necessary data concerning the older pavements. Such studies will be made, however, as pavements laid within the past few years become older, and with a more complete record of later years, analyses may be made on any number of different bases. It will also be possible to trace in-

FILE No. 458

St. Washington Boul. From Austin Boul. To 72nd Ave. Spec. No. 308 Contr. Am. Asph. Pav. Co.
Kind Pav't 2" Asph. Conc. Kind Base 4" Conc. over old macadam Kind A. C. Trinidad Kind Flux No. Record
Kind Cem. in base No. Record Kind Aggregates in Base Crushed limestone & Screenings Kind Soil Blue K. Top. - Clay. Sub.
Aver. Penetration No. Rec'd Length 8173' Sq. Yds. 35359 Date base laid June 1913 Date top laid June & July 1913
Remarks Oak Park Mix. with squeegee & ¼" granite chips. Very heavy Boulevard Traffic.

INSPECTION		Trans. Cracks		Longitudinal Cracks	Cracks showing "heave"	Depressions ½" or more deep	Depr. due to failure of base	MAINTENANCE		REMARKS
Date	by	More than ½ width	½ width or less					Sq. Yds.	Year	Out of Reserve Aug. 1918
Mar. '17	H.W.S.	20	54	12						Considering Heavy Traffic - in excellent shape
Mar. '18	H.W.S. K.Y.P.	124	67	31	31		3	123.9	1918	Repairs made Aug. 1918 as follows :- Acct. pushing = 85.1 yds.; acct. heaved cracks = 13.6 yds; acct. failure of Base = 21.2 yds; and acct. misc. = 4 yds.

CARD RECORDS OF EACH PAVEMENT CONTRACT ARE KEPT AT OAK PARK

ANALYSIS OF CONDITION OF ASPHALTIC PAVEMENTS AT OAK PARK, ILL., WITH REFERENCE TO KIND OF ASPHALTIC CEMENT USED; FROM INSPECTION MADE IN MARCH, 1918

1½-inch Sheet Asphalt on 1½-inch Binder on 6-inch Concrete Base

Year Laid	Kind of Asphalt Used	Lgth. Miles	Sq.Yd.	Cracks: Transverse More Than Half Width No.	Per Mile	Per 1000 Yds.	Transverse ½ Width and Less No.	Per Mile	Per 1000 Yds.	Longitudinal No.	Per Mile	Per 1000 Yds.	Showing Heave No.	Per Mile	Per 1000 Yds.	Depressions: ½ In. or More in Depth No.	Per Mile	Per 1000 Yds.	Due to Failure of Base No.	Per Mile	Per 1000 Yds.	Maintenance Sq. Yds.	Per Mile	Per 1000 Yds.
1906	No record	0.50	6,968	52	104	7.5	101	202	14.4	38	76	5.4	9	18	1.3	569	1,138	81.8	403	806	5.8	63	126	9
1907	No record	0.77	11,669	58	75	5.0	125	163	10.7	3	4	0.31	10	13	0.9	206	268	17.6	48	62	4.1	53	69	4.5
1908	No record	1.21	18,396	215	177	11.7	146	121	8.0	22	18	1.2	83	69	4.6	237	196	12.9	41	33.9	2.2	60	50	3.3
1910	No record	1.49	23,539	109	73	4.6	205	138	8.7	25	17	1.0	61	41	2.6	255	171	10.8	102	69	4.3	83	56	3.5
1914	Mexican	2.76	43,667	133	48	3.0	31	11	0.7	0	0	0	50	18	1.1	15	5.4	0.3	0	0	0	24	8.7	0.6
1916	Trinidad-Mexican	0.26	2,574	0	0	0	0	0	0	0	0	0	0	0	0	2	7.7	0.8	0	0	0	0	0	0
2-Inch Asphaltic Concrete on 6-Inch Concrete Base																								
1911	No record	0.91	14,543	37	41	2.5	47	52	3.2	18	20	1.2	4	4.4	0.4	23	25	1.6	1	1	0.07	338	372	23
1912	California	2.00	33,971	70	35	2.1	371	186	11.0	93	46	2.7	0	0	0	43	22	1.3	1	0.5	0.03	528	264	15.5
1913	Trinidad	1.10	17,160	20	18	1.2	34	31	1.9	0	0	0	4	3.6	0.23	20	18	1.2	4	3.6	0.23	2.8	2.5	0.16
1914	Trinidad	0.13	2,028	13	100	6.4	10	77	4.9	0	0	0	4	31	2	0	0	0	0	0	0	0	0	0
1914	Mexican	7.59	122,172	510	67	4.1	150	20	1.2	50	7	0.4	183	24	1.5	145	19	1.2	11	1.5	0.09	235	31	1.9
1915	Mexican	2.38	38,150	78	33	2.8	27	11	0.7	8	3	0.2	31	13	0.8	74	31	2.0	7	3	2	174	73	4.6
1915	Trinidad	0.78	13,648	28	36	2.6	10	13	0.7	9	11.5	0.66	10	13	0.73	6	8	0.4	0	0	0	0	0	0
1916	Trinidad-Mexican	1.25	19,292	37	30	1.9	25	20	1.3	0	0	0	11	9	0.57	31	25	1.6	7	5.6	0.36	0.5	0.4	0.03
1916	Aztec	1.49	23,680	123	83	5.2	21	14	0.9	5	3	0.2	30	20	1.3	1	0.7	0.04	0	0	0	1	0.7	0.04
1916	Trinidad	6.32	97,244	253	40	2.6	64	10	0.66	7	1	0.07	99	16	1.0	22	3.5	0.2	3	0.5	0.03	0	0	0
1917	Trinidad	1.46	26,716	32	22	1.2	9	6	0.34	4	3	0.15	4	3	0.15	1	0.7	0.04	0	0	0	0	0	0
2-Inch Asphaltic Concrete on 4-Inch Concrete Base Over Old Macadam																								
1913	Trinidad	1.55	35,359	124	80	3.5	67	43	1.9	31	20	0.88	31	20	0.88	0	0	0	0	0	0	0	0	0
1916	Trinidad-Mexican	0.48	7,823	21	44	2.7	2	4	0.25	0	0	0	2	4	0.25	0	0	0	0	0	0	0	0	0
1916	Trinidad	2.36	38,536	49	21	1.3	12	5	0.3	8	3	0.2	2	2	0.85	0.06	3	1.3	0.08	1	0.4	0.03	2	0.85	0.06
1917	Trinidad	0.53	10,142	2	4	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Inch Asphaltic Concrete Over Old Macadam																								
1912	Trinidad	0.13	2,480	0	0	0	0	0	0	0	0	0	0	0	0	2	15	0.8	0	0	0	23	177	9.3
1914	Trinidad-Mexican	0.39	6,232	0	0	0	0	0	0	0	0	0	0	0	0	5	13	0.8	0	0	0	0	0	0
1915	Mexican	0.49	8,057	0	0	0	0	0	0	0	0	0	0	0	0	6	12	0.7	1	2	0.12	23	47	2.9
1915	Trinidad	0.14	1,509	0	0	0	0	0	0	0	0	0	0	0	0	2	14	1.3	0	0	0	16	114	10.6
1916	Mexican	0.06	1,125	0	0	0	0	0	0	0	0	0	0	0	0	1	17	0.9	1	17	0.9	2	33	1.8
1917	Trinidad	0.79	12,285	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

dividual paving jobs through consecutive years, thus providing interesting comparisons between the average results in individual jobs and those here presented.

In considering the data collected, the significant absence of cracks in pavements laid on reshaped macadam roadways is at once apparent, indicating that the defects in those on concrete base are due to the base. A 4-in. concrete base laid upon old macadam, likewise, shows much less tendency to crack than do pavements on 6-in. base, laid directly upon the natural soil. The conclusion is that the presence of the macadam facilitates drainage immediately beneath the concrete.

We have found on the average that 14% of all cracks in asphaltic concrete pavements, up to seven years old, cause an upheaval of pavement. Most of the heaving is apparent in the late winter and early spring, during periods of alternate freezing and thawing. This leads to the conclusion that the heave is caused by the freezing of water which is admitted through the cracks at each thaw.

The presence of the binder course in sheet-asphalt construction apparently has some effect in delaying the surface reproduction of cracks occurring in the concrete base. With a bituminous mixture serving as an absorbing medium, cracking of the wearing surface is not prevented; it is merely delayed.

Another significant fact is that asphaltic concrete pavements laid over old macadam have shown no sign of "pushing" or "rolling" under heavy traffic, while the same pavements on concrete have given considerable trouble in this respect. In one instance, on a street having both types of construction, this difference has been very marked. Sheet asphalt, including boulevard pavements, has shown almost no tendency to push.

Tendencies toward longitudinal cracks, and cracks resulting in subsequent upheaval of pavement, seem to show the same relation between the types of pavement as those toward transverse cracks. The kind of asphalt used had practically no effect on the number of cracks.

In studying the maintenance rate for the four types of pavement, it is necessary to call attention to the fact that all the maintenance on pavements laid directly upon old macadam could have been prevented, as most of it, with the exception of a few yards of surface replacing of scorched material, was due to settlement of backfilling over trenches. Had these trenches been filled as they now are in Oak Park, this maintenance would have been unnecessary. Our experience with bituminous-concrete pavement has shown that those laid directly upon old macadam not only cost less for construction and maintenance, but also are in much better general condition after several years' service.

In order to minimize the movement of the wearing surface, the concrete base, for those having one, is finished rough. We have found that these pavements are inclined to assume, in a measure, the rough surface of the concrete. In comparison with those laid on old macadam, this feature is quite noticeable. This fact has led the writer to reduce, considerably, the roughness of the concrete surface.

It is well-nigh impossible to repair cracks in a bituminous pavement on a concrete base, so that they will not reappear and again provide means of admitting water. However, it is possible to relieve, in a measure at least, the upheaving at a crack by means of replacing the cement concrete base with bituminous concrete of sufficient extent to waterproof the structure. This, however, is expensive, and contractors dislike very much to make such repairs. Moreover, the practical value of the method is not firmly established. The repair is effected by digging out the base under the crack to a width of 6 or 8 in. and filling with bituminous concrete, upon which a new surface is placed.

That cracks are serious defects, in so far as bituminous pavements are concerned, is evident, and the older the pavement becomes the greater will be the frequency of the cracks as shown by this investigation. Undoubtedly, poor subdrainage is often the cause of cracks in concrete bases and concrete pavements; and, by providing proper drainage and expansion joints, they

may largely be eliminated. The cost of this, however, is often so high that it would mean the death of the proposed improvement, and a cheaper construction with less efficient drainage would be adopted. Furthermore, expansion joints in concrete base under a bituminous pavement cause cracks in the surface material at each joint. Therefore, with three joints to each 100 ft. of base, or 160 per mile, cracks in the surface would be produced at the same rate.

The number and seriousness of defects which result in maintenance expense should be considered as an index to the serviceability and cost of the pavement. If these defects are inherent in the pavement, they may be expected to appear at a certain rate, depending largely on local conditions, as long as specifications and construction comply with good practice. If it be true that certain defects are inherent and unpreventable, but two courses are open—the one to abandon that type of construction, the other to continue the use of the pavement, knowing that certain results must follow.

It has been said that if bituminous concrete is used as a foundation material we must exercise special care in the preparation of drainage and subgrade, and while present practice lays little stress upon these points in concrete-base construction, it is nevertheless true that equal care should be taken, if we are to expect first-class results. The chief argument in favor of concrete has been that it bridges over unstable subgrade. As now laid, concrete has failed in this regard under the stress of modern traffic. There would seem to be no reason for laying the concrete base, save that special effort in subgrade preparation is avoided. Given an ordinarily dry subgrade, good results should be obtained from the use of an all-bituminous pavement.

Large-Capacity Well Installation and Operation

Tuning-up Process with Gravel Insertion Stabilizes Yield—High Overall Efficiency Obtained With Six-Stage Pump

CAREFUL records of methods used in tuning up a 30 to 36-in. bored well having a maximum capacity of 1000 gal. per minute, at the University of Illinois, as well as subsequent data, are given in a paper presented by Prof. M. L. Enger to the Illinois Section of the American Water-Works Association. Early intermittent operation to increase capacity, insertion of gravel, with resulting high yield per foot of draw-down, unusual hydraulic behavior during long-time tests, a clay seal at the top to protect the water from pollution, a recording water-level gage and a simple vertical jet apparatus to measure the flow, are points emphasized in the paper.

Water for the university is obtained from this well and five others, the latter being 8 and 12 in. in diameter, sunk into the glacial drift to a depth of about 140 ft. and yielding 6 to 80 gal. per minute. The new well is 36 in. in diameter for 160 ft. and 30 in. for the next nine feet.

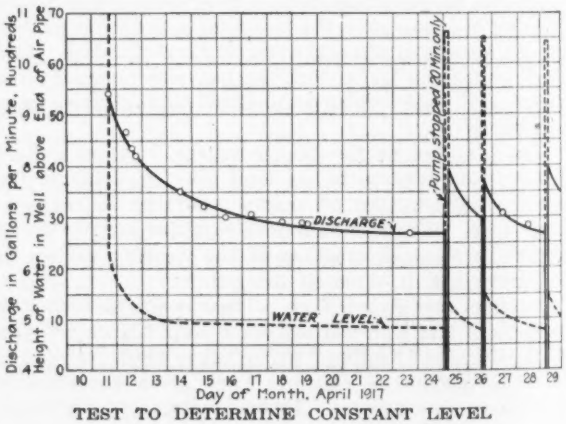
It was drilled in 1916 by the Layne & Bowler Co. by the rotary process in 3½ months, and the payment was on the basis of $19 per gallon per minute after one year's operation, with a guaranteed minimum overall efficiency for motor and pump of 55%. The cost of the previously drilled wells, motor and reciprocating pumps ranged from $934 to $2106.

The driller furnished the following log of the new well: Clay and gravel mixed, 50 ft.; clay and rock, 15 ft.; hard clay and sand mixed, 30 ft.; hard sand and gravel, 47 ft.; very hard and fine sand, 26 ft.; hard sand and little clay, 5 ft. The well was completed by putting in 98 ft. of 24-in. casing; 70 ft. of 24-in. Layne patent shutter screen, and 4 ft. of 16 x 22-in. shutter seal with a 6-in. cypress bottom. The space between the screen and casing and the wall of the well was filled with 1-in. gravel.

The tuning-up process consisted of alternately starting and stopping a temporarily installed turbine pump, in order to break down and wash away the mud wall left by the drilling process, and also to carry out the finer sand in the water-bearing stratum near the well. It was hoped in this way to form a cavity under the heavy clay roof, indicated in the above log, into which the gravel would flow and thus increase the capacity of the well. The driller stated that 30 cu.yd. of gravel were fed in at the top.

A preliminary test showed a yield of more than 1000 gal. per minute with a draw-down of 53 ft., or a specific capacity of more than 19 gal. per minute per foot of draw-down. The well now has a specific capacity of 21.5 gal. per minute. A 12-in. well at the university, tested immediately after its construction in 1906, showed a yield of 108 gal. per minute with a draw-down of 15 ft., or a specific capacity of 7.2 gal. per minute. In 1916 its yield was 4.9 gal. per foot of draw-down per minute. That is, the 10 years of operation reduced its specific capacity more than 30%, while the new well in about two years of normal use has had its specific capacity increased by about 10 per cent.

It was soon found that a yield of 1000 gal. per minute could not be maintained for any length of time without gradually lowering the water level in the new well and in the older wells. A test was begun Apr. 11, 1917,


Discharge in Gallons per Minute, Hundreds
Height of Water in Well above End of Air Pipe
Pump stopped 20 Min. only
DISCHARGE
WATER LEVEL
Day of Month, April 1917

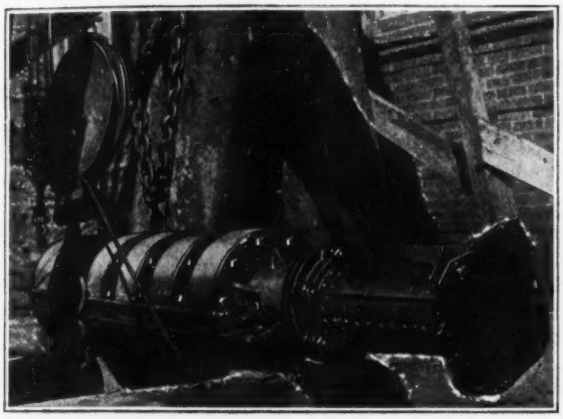
TEST TO DETERMINE CONSTANT LEVEL

in which it was intended to run the pump continuously until the water level in the well should become constant. The water went down quite rapidly during the first two days of the test and continued to go down slowly until the morning of Apr. 25, when some trouble at the switchboard caused the circuit breaker to blow out, stopping the pump. It was started again about 20 minutes later, but during the interval the hydraulic con-

stants of the well had been changed greatly. The discharge had been about 670 gal. per minute for several days. When the pump was started again the discharge was about 790 gal. and 24 hours later was about 710 gal. per minute. The rapid change in the hydraulic constants is attributed to the behavior of the fine sand drawn toward but not into the well during the continuous operation, which by readjustment during the brief cessation of pumping was allowed to wash into the well upon resumption of pumping, thereby leaving the water passages less restricted.

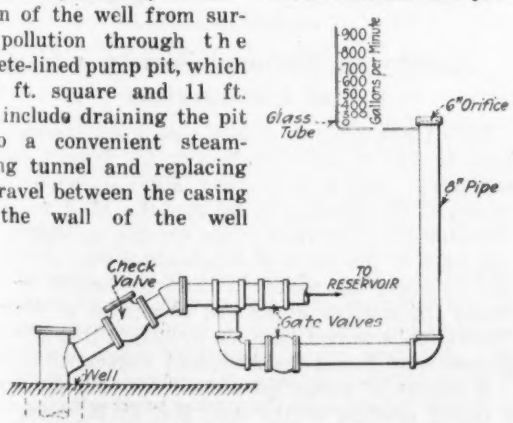
In the acceptance tests made Dec. 28, 1918, the permanent installation, consisting of a six-stage, 15-in. pump, driven by a 50-hp. two-phase induction motor, showed an overall efficiency of 55.6% when delivering 587 gal. per minute against a head of 136.9 ft., and of 59.3% delivering 536 gal. against 156.4 feet.

Compared with the other well equipment at the university, the new one has the disadvantage of 15 ft. greater draw-down. But since it has never been possible



FOOTPIECE PERFORATED IN CASE BOTTOM OF WELL BECOMES SEALED

to maintain the average efficiency of the reciprocating well pumps as high as 50%, the turbine pump will get the water out of the ground with a smaller power consumption than the reciprocating pumps. With the older equipment the cost of maintenance has amounted to about 0.8c. per 1000 gal. The new equipment has not been in use long enough to draw definite conclusions, but the indications are that the maintenance cost will be comparatively small. Precautions for the protection of the well from surface pollution through the concrete-lined pump pit, which is 12 ft. square and 11 ft. deep, include draining the pit into a convenient steam-heating tunnel and replacing the gravel between the casing and the wall of the well



PIPING IN VERTICAL JET APPARATUS

with clay to a depth of 6 ft. below the floor of the pit. Frequent tests indicate the water is of excellent sanitary quality.

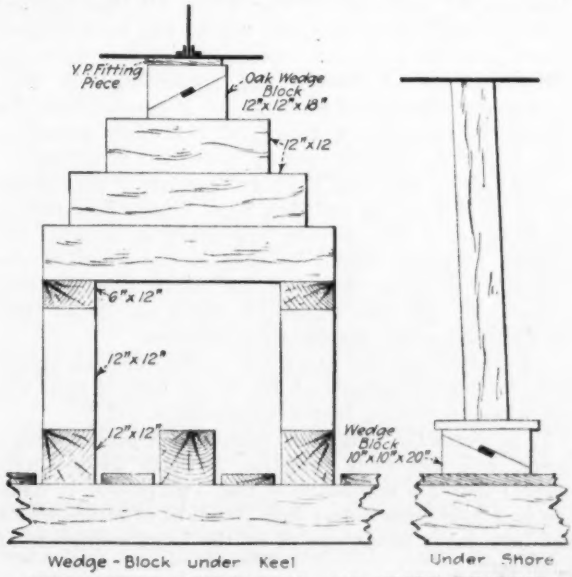
To obtain continuous records of the water level in the well, a recording gage is used to record the pressure required to keep a small quantity of air bubbling from the end of a 1½-in. pipe which hangs in the well and extends below water level at all times. The pressure in the air pipe is equal to the head of water above the end of the pipe, hence the gage shows the submergence of the end of the air pipe. The records show when the pump is started and stopped and are found very useful in the preparation of statistics of operation.

Discussion of the paper brought out three other means of determining the water level. A weighted, small-bore rubber tube is dropped between the casing and the inner pipe. By connecting the top end with a glass U-tube filled with water, the instant at which the lower end strikes water is readily noted. Electrically the level may be determined by protecting the ends of two insulated wires dropped from the sides of the pipes. A telephone battery and buzzer equipment complete the outfit. If the space between the inner and outer pipes is too small to insert anything, the whole concentric space may be sealed off and used as an air pipe, as Professor Enger used his 1½-in. pipe.

A New Quick-Release Keelblock

A WEDGE keelblock of new form, invented by a shipwright at the yard of the Federal Shipbuilding Co., Kearny, N. J., was tried out recently in the launching of the hull of the "Waukegan," a 9600-ton steel ship. The block was used on one of the keel supports and also under a shore, as sketched herewith. It worked successfully.

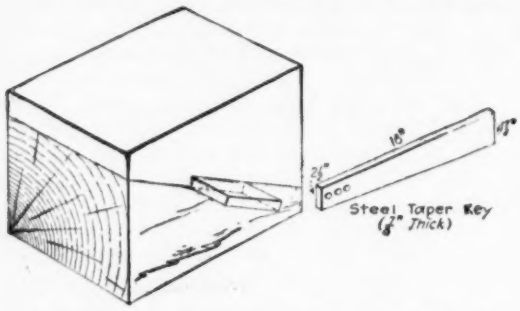
In construction, the block is a pair of wedges with the inclined faces rabbetted to receive a steel taper key holding the halves of the block from sliding. The block itself is 12 x 12 x 18 in. over all, and is cut with an inclination of about 1 on 2 for the wedge faces. The key is about 1 in. thick, 2 to 2½ in. wide at the point, and tapered 1:10 to 1:12. It was originated by



NEW WEDGE KEELBLOCKS AND SHORE BEARING

Eugene Lantz, of Jersey City, N. J., who has applied for a patent on the device.

In the launching of the "Waukegan" the wedge keelblock and a nearby shore supported on a similar but smaller (10 x 10-in.) wedge block were left as the last



QUICK-RELEASE WEDGE BLOCK DEVISED BY E. LANTZ

supports to be removed. They had been placed under the heaviest part of the ship, near the engines, and the gradual settling of the vessel as the shores were knocked out and the keelblocks split away subjected them to an abnormal load. Nevertheless, the shore released itself promptly, with a sharp kick, when a blow with an 8-lb. hammer knocked out the taper key. Thus the use of the self-releasing block eliminated the need for the heavy ramming required to knock out shores as ordinarily supported, which delays the launching and destroys a large number of shore timbers at each launching. In releasing the keelblock wedge the operation was not as quick and automatic, but a light blow dropped the two halves of the block apart after the key had been knocked out.

As a strength test, a model block made one-sixth the size of the original, or 2 x 2 x 3 in., was subjected to compressive load in a testing machine at the mechanical laboratory of Columbia University. The block, made of oak, carried a maximum load of 14,000 lb., at which stage signs of crushing appeared along the lower edge of the block. No sign of failure was noticeable at the taper key recess, and the sliding faces of the wedges showed no effect. The block released under load the moment the key was driven out.

The taper key permits the adjustment of the height of the block, in the laying of a new keel. As a means of locking the block against accidental disturbance of the key, there is a series of holes in the tail of the key to receive a ½-in. bolt.

With a block similar to that shown, but fitted with a double key, a 14-ton stern post was easily lifted off its blocking, and as easily lowered again. The block is not intended for such service, however, and is designed primarily for use as a releasing support on keelblocks and bilge cribs and under shores.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Effectiveness of Strike Weapon in Raising Salaries

Sir—The railroad engineers' conference on salaries, described in your issue of Mar. 27, p. 612, is a marked forward step in this important matter and reflects much credit upon the American Association of Engineers for promoting the conference and presenting the well-worked-out schedule of salaries, but it appears that the conference expressed a temporizing attitude toward a very important question put by one of the conferees.

The account tells that, during the course of an address by W. W. K. Sparrow on "How Shall Proper Recognition Be Obtained?" the question was asked as to what the speaker proposed should be done in the event of the railroads' refusing to accept the salary schedule presented. Mr. Sparrow replied, "I would not strike," and his declaration was greeted with applause.

No positive answer was given to the question except this, "After the lessons of the war I believe men will get what, in justice, they are entitled to get."

It is perfectly true that men, and especially engineers, will get what injustice (written as a single word!) they are entitled to if they still persist in holding to a long since out-of-date standard of ethics which has been taken advantage of by the large employers of engineers.

The proposed salary schedule and all other matters pertaining to the standing and welfare of technical railroad engineers is still, and always will be, for the railroad companies to accept or reject as they choose, unless the engineers are organized and fully prepared to exercise the one final and only really effective weapon of the strike. We should, by all means, use every other possible device to obtain adequate recognition before resorting to the extremity of striking. But if engineers were so organized that they could, and would, strike effectively, it would lend very great weight indeed to fair and just representations that might, from time to time, be laid before the employers of engineers.

Mr. Sparrow suggests that the proper line of action is to organize to give the whole profession a single voice, with licensing and broader education. These are all proper and commendable plans, but they will take a long time to mature, and still longer to bring about the urgently needed increases in engineers' salaries.

Niagara Falls, Ont. REX P. JOHNSON.

Apathy in National Society a Cause of Unionization

Sir—There are two rather significant items in your issue of Apr. 10, 1919, bearing on the present status of engineers. The first is your editorial indicating the apathy of the members of the Am. Soc. C. E. toward the Development Committee of the society, an apathy probably born of the years of hopelessness that any suggestion to make the society a little bit human or to increase the number of its red corpuscles is doomed to failure. The second item, on p. 737, is that Boston engineers have joined the American Federation of Labor.

A matter of somewhat similar interest developed at a recent meeting of the Am. Soc. C. E. when it was asked that the members present discuss a proposed en

gineering project of importance (the vehicular tunnel to New Jersey) with a view to an expression of opinion as to the feasibility, or otherwise, of the project; in other words, they were to give an opinion for nothing.

In connection with the war, engineers, in common with men in all walks of life, freely gave of their time and experience for little or no compensation of a monetary nature, but in time of peace it seems to me that if our national, state or municipal authorities need engineering advice they should pay for it at the regularly established rates, and not attempt to get it gratis under the guise of reconstruction or any other form of camouflage. Engineers, whether of the national railroads, employees of Public Service Commissions, or others, should be recognized as at least of equal importance with the labor unions, without resorting to strikes to enforce their demands.

Personally, I do not at all like the idea of unionizing under the American Federation of Labor any body of professional civil engineers. There are other ways of succeeding, and engineers really worthy of the name (who realize that their profession is much broader and needs a much broader outlook than the mere technique of running a transit, making a plan, or calculating the stresses in a bridge) will succeed without the aid of any labor union; in fact, the generally understood attitude of the labor union is fatal to the necessary vision of the successful engineer. In order, however, to avoid forcing the younger members into the labor unions, there can be no question that the national engineering societies should be vehicles for the continual promotion of the interests of the engineering profession, not merely by the formal presentation of technical papers but also by such action as that recently taken by the Engineering Council in regard to the wages of railway engineers, and the stimulation of interesting meetings.

I suggested, several years ago, the study of methods of other societies, with a view to making the Am. Soc. C. E. more human. The late J. E. Johnson, Jr., pointed out very recently (see *Engineering News-Record* of Apr. 3, 1919, p. 688) the need for directors chosen for their ability to direct rather than as a pension for past services. The secretaries, particularly, need to be in touch with the world, with the current activities of the profession and in sympathy with the members—not merely editors of technical papers, reporters of meetings and guardians of the treasury, all of whom are necessary and desirable but far from meeting the needs of the profession.

I believe that unless our leading technical societies find a solution of the many social problems confronting the engineer; help him to reëmployment if he needs it; see, so far as it is possible to do so, that he receives adequate compensation; take up actively such questions as those recently developed in connection with the Public Service Commission of New York, etc., many of the younger members will be forced into the ranks of the labor unions. This will be, in the long run, as unfortunate for them as for the whole profession.

I think there is at least beginning to be a realization of the need of this help to younger engineers by the established societies, and I believe that *Engineering News-Record* could do perhaps more good than any other agency by keeping the need, the efforts made to meet it, and the results obtained, prominently before all members of the profession. F. LAVIS.

New York City.

Economic Betterment of the Engineer

Sir—Has this war with all its intrigue and violence been sufficient to awaken us from our apathetic, mesmeric belief that we were too professional to consider the economic betterment of our profession? It is safe to assume that it has, in the majority of the profession. Then, taking it for granted that we are sufficiently awake to realize the new order of world progress, we can no more go back to that sluggish, self-satisfied, every-man-for-himself system, than the oak can return to the acorn.

Now, the problem that confronts us is the obtaining a fair day's pay for a fair day's work. Can we look to the societies and associations for the solution of this problem? Judging from past experiences, No. They in the past have been stupefied by an exaggerated sense of self-importance, dreaming away the hours, unmindful of an economic betterment for members or co-workers; publishing voluminous papers for which no real, live worker can spare the time to extract the useful from a mass of matter. Let us hope that the societies and associations synchronize with the new order of things, and become more progressive, for the complete betterment of all.

Can the individual worker do anything to promote his economic betterment? No. Not while he works alone. Those of us who during the war were connected with Government and municipal work had a chance to realize how insignificant we were individually. In one instance there were about 250 engineers, working from 10 to 14 hours a day and seven days a week, who felt that they were not being treated fairly as regarding pay, and hours of work. They decided to see if there were not some means of obtaining a decrease in the hours of labor, if nothing more; held a meeting; sent a letter to the "chief pundit" asking for an explanation of the Government's attitude in requiring excessive hours of labor, but only eight hours' pay per day.

After waiting an unreasonable length of time for an answer, the committee decided to have a personal interview with the "chief pundit"; and in answer to their demand for a reason for utter disregard of their previous requests they were told that there was not time to take the matter up, and to rest assured that there would be a just settlement, either in shorter hours of work, or a possibility of their being compensated for all overtime.

This seemed satisfactory to all, until it was discovered that every week men were leaving, credited with numerous hours of overtime without receiving compensation for the same. It soon became apparent that something more drastic should be done.

The carpenters on this job decided that they needed a substantial increase in pay; and when their request failed to meet their expectations, about 80% of their number started to leave the works. They were stopped by headquarters and assured that they would be given all they demanded, and that the increase would start from the time they commenced work on that job.

The only possible solution of the problem seemed to be in unionization. When you say "unionize" to a professional man you are sure to meet that threadbare argument: that we are professional men, not laborers. Even so, what, may we ask, have we received in return for all our professionalism? John M. Goodell in *Engineering News-Record* of Mar. 6, 1919, p. 482, says: "It may be found that a very large part of the

work done by engineers is really little more than skilled labor." Assuming he is right, one would naturally suppose that their compensation would be a little more than that of the skilled laborer, instead of being less than that of the so-called common laborer.

After many meetings the engineers of Boston and vicinity decided to obtain a charter from the American Federation of Labor, and now have a union that can give a good account of itself, and which will need to be reckoned with in the future. We know that, in so far as our demands are just they will be granted; that the Golden Rule is applicable to business, and the business that does not apply it in some measure is bound to fail. It is time for us to get together in one strong unit for the economic betterment of all, and in doing so we may dim the fires of Bolshevism, I. W. W. and O. B. U.

LOUIS FISHER.

Waltham, Mass.

Another Formula for Weights of Steel Roof Trusses

Sir—The article in your issue of Mar. 20, 1919, p. 576, entitled "Weights of Steel Roof Trusses by Empiric Formulas," by R. Fleming, was read by the writer with much interest, in view of the fact that he has prepared a table to give close approximate weights of steel roof trusses, for the purpose of preparing preliminary estimates on factory buildings. A print of this table is herewith inclosed.

The basis of this table is the formula shown thereon, which was devised by the writer by combining the two well known formulas of Ketchum and Ricker, referred to in Mr. Fleming's article. Having at hand some accumulated data on the weights of steel roof trusses, which had been detailed by our office, and on others for which we had prepared detailed lists of material for estimates, the writer applied a number of the text-book formulas, hoping to find one which would agree fairly well with our estimate data. But no single formula gave results even approximately close. It was found that the Ricker formula gave weights which were too low and the Ketchum formula gave weights which were too high to agree closely with our data. After making a study of the two formulas, and carefully reading the explanation of the Ricker formula in the University of Illinois Bulletin No. 16, it occurred to the writer to combine the two formulas, thereby making use of the span factors in the Ricker formula and the distance center to center of truss factor and variable load factor in the Ketchum formula.

This was tried and a coefficient for the variable load factor was determined by trial with a slide rule. The following formula resulted, and gave weights which were surprisingly close to our data:

$$W = \frac{P}{92}\left(1 + \frac{S}{25} + \frac{S^2}{6000} + \frac{S}{5\sqrt{A}}\right)SA$$

in which W = total weight of truss; P = carrying capacity of truss, exclusive of its own weight in pounds per square foot of horizontal projection; S = span in feet; A = distance center to center of trusses.

Again referring to Mr. Fleming's article, the weights for the three trusses of 40-, 60- and 80-ft. spans, bays 16 ft., load equivalent to 40 lb., given by this formula are 1356, 2920 and 5156 lb., respectively; and for those trusses of similar spans and bays, but with a load of 56 lb., the weights are 1898, 4088 and 7218 lb., respectively.

It will be noted that in general these weights more nearly agree with the estimated weights than those of either the Ketchum or the Ricker formula, especially for the shorter spans.

The table of weights of steel roof trusses prepared from the formula is self-explanatory. It has proved a reliable guide in checking estimates, in giving the weight of trusses for design purposes, and has been used a number of times by the writer in preparing a preliminary estimate without making any design of trusses.

It would be interesting as well as instructive to have others of your readers apply it to their roof-truss data and report the results obtained.

MARSHALL L. MURRAY,

Steel Superintendent, Concrete Shipyard, The A. Bentley & Sons Company.

Jacksonville, Fla.

Who Can Solve This Contractor's Problems?

Sir—We of course are interested in looking through the "Hints for the Contractor" in your estimable journal, and for a long time have expected to see some contractor come to the front with certain much-needed devices.

One is a device for spreading screenings on water-bound macadam-road work. This work is nothing less than drudgery. All specifications provide that the screenings "shall be whipped on." Dropping or shoveling on will not do, and on any work of this kind you will hear the contractor moaning for some such device.

The writer has an idea and believes it is practical. As now required, screenings must be piled along the work at intervals, say of 15 to 20 ft. My idea is to pile them in large piles 50 ft. apart and then use a mounted blower with a receiving hopper large enough for two

WEIGHTS OF STEEL ROOF TRUSSES

The table gives weight of truss for a capacity of one pound. To find total weight of truss, multiply value in table by capacity of truss in pounds = P.

	Span of truss in feet, out-to-out of bearings (S)																		
A*	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	110	120
6	4.6	6.8	9.4	12.5															
8	5.7	8.4	11.7	15.5	19.8	24.7	30.2												
10	6.8	10.2	13.9	18.3	23.5	29.3	35.8	42.9	50.8	59.4									
12			16.0	21.1	27.0	33.6	41.1	49.3	58.4	68.3	79.0	90.5							
14				23.8	30.5	37.9	45.6	55.6	65.8	76.9	89.0	102.0	116.0	131.3					
16					33.9	42.1	51.4	61.7	73.0	85.4	98.8	113.2	128.9	145.7	163.6	182.6	202.7		
18						46.3	55.4	67.7	80.1	93.7	108.5	124.1	141.4	160.2	179.5	200.4	222.5	271.1	
20							61.4	73.6	87.1	101.9	117.9	135.0	153.8	173.7	195.3	218.1	242.1	295.0	353.8
22								78.8	94.7	110.0	127.2	145.7	166.0	187.6	210.7	235.1	261.4	318.5	382.0
24	For general purposes, P = 60 lb.									117.8	136.4	156.1	178.0	201.1	226.2	252.2	280.3	341.6	409.5
26												166.9	189.9	214.6	241.1	269.3	299.8	364.7	437.7
28														228.5	256.0	286.0	317.8	387.2	465.0
30															271.1	302.7	336.3	410.2	492.1

*Distance c. to c. of trusses in feet = A.

men to shovel into, the blower to have a flexible metal hose say 35 ft. long. The power plant could be a gasoline or oil motor. Mud, muck, sawdust, concrete and a number of other commodities are blown through hose and pipes, why not screenings? Two men shoveling from piles and one on the hose will do more work than six men carrying one shovelful at a time a distance of from 5 to 30 ft. and spreading it. A shovelful of screenings has considerable weight, and, when it is carried all day it doesn't take long for a worker to begin to look for another job.

The other item is a turntable for motor trucks. When the truck owner sees his expensive equipment being nosed into ditches and over rough fields for turning purposes, see-sawing to make the turn in narrow places or backing long distances from places fit to turn in, and realizes the time lost as well as the wear and tear on equipment, it is patent to him that a turning base is an absolute necessity.

We are bringing this to your notice in the hope that you may be able to present something practical on the two subjects. Someone will do real business with contractors if he will bring out practical devices on these lines. FRED C. BEAM.

Lima, Ohio.

The Engineer As a Physical Economist

Sir—May I offer something between definition and discursion?

Engineering is the science of cost analysis. An engineer is a physical economist. Everyman knows the engineer as one who evaluates, although the word evaluate, perhaps, will not occur in Everyman's vocabulary. The engineer is fundamentally an estimator, a man with a mathematical pencil, and is a prover rather than a speculator. He calculates stresses and strains, tests materials, records performance of men, machines, and forces of nature, derives and applies formulas. Why? To arrive at development or production costs by a method superior to cut-and-try, or rule-of-thumb.

Engineers, now as formerly, are military or civil; the former, waymakers for the forces of war and inherently destructive; the latter, always taking the element of economy into account and inherently constructive. When military engineers construct, expediency is paramount to economy. Mining, structural, electrical, mechanical, chemical, sanitary, agricultural, also architectural, are terms which designate the field of activity of the civil engineer. A competent mining engineer, for example, must have at least a working knowledge of hydraulic, mechanical, electrical, and perhaps other branches of civil engineering; yet he is essentially a physical economist, and although he may fancy himself ever so self-contained, he can never fly very far from the parent body on his own tangent.

As between those who toil and those who spin, classify engineers with the latter. A civil engineer usually spins for another, and ever must needs be compensated with a stipend, rational rule ignored. He is neither a producer of wealth directly, narrowly considered, nor yet a parasite on humanity. An outlander in the business world, he is requisitioned, like Daniel, to visualize and interpret dreams; but no one expects him to promote or participate. Does the gambler, or banker, dream of a fertile valley replacing an arid waste? His engineer will interpret the dream in terms of a specified dam and irrigation works. Does the trader dwell in a mansion? His architect schemed it. Utility and efficiency gaging the engineer, utility and beauty guiding the architect. A 4H for the one, a crayon for the other, and in either case "How much will it cost?" and "Good morrow, professor."

Comparing Socialists with engineers, the former expect to reduce work and eliminate profits; the latter are expected to work hard and forego profits. The engineer may be likened to a medieval grist miller grinding corn and retaining barely enough meal for supper. What miller nowadays is satisfied with one little mill, and grinding only? An engineer sometimes gets above (at least more potent than) the purely professorial and single-phased class which remains untouched by the lucre of gain—and becomes successful as a contractor or other master spinner. Whenever he arrives, discovers himself, plays his initiative, his fellows are no longer solicitous as to his status, and seldom bother themselves about his ethics.

Engineers as such do not engineer. They design, construct, valuate, report, or what not that is decent; while promoters, politicians, or schemers, engineer. The noun is honest, but the verb implies astuteness and is taboo.

It seems to me engineers could and properly should engineer, and that without any lowering of ethical standards. At least, they should endeavor to engineer their own fortunes, but there appears to be small hope so long as they remain deficient in everything but efficiency and oblivious to the uses of imagination. Instead of being satisfied when they have determined what it will cost, if they will step over the threshold and interest themselves as to what it will win, realizing that the word "win" implies "venture" and "contest," if they will move their standard up from responsible charge to responsibility, perhaps they may be expected to represent something.

Question: Has the engineer anything that he can capitalize or even enterprise, or is he inherently a peon? What is his logical status? C. P. KEYSER.

Portland, Ore.

Correction

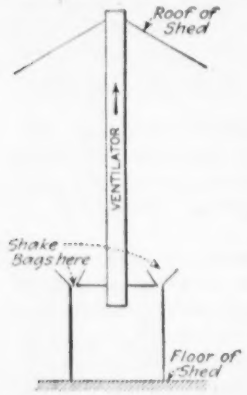
The following corrections should be made in the article, "Field Methods on Rapid Stadia Surveys at Columbus," published in *Engineering News-Record* of Apr. 17, 1919. Starting at line 8, column 2, p. 776, it should read: "Primary traverses averaging 15 miles in length were easily kept within an error in minutes of angle of one-half the *square root* of the length of the traverse in miles, and within a linear closure of 1 in. 1500, while levels always checked between United States Geological Survey bench-marks *in feet*, as well as five-hundredths *times* the square root of the miles of levels." Starting with line 7, column 1, p. 777, it should read: "If the level reading were taken *after* the distance had been read on a shot, it would be taken first on the next shot, thus saving the time necessary to reset the bubble." Loose-leaf notebooks were not used on this work, as indicated by the perforations shown in the illustration, but two ordinary transit notebooks were used alternately, so that the notes in one could be plotted while the other was in use.

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

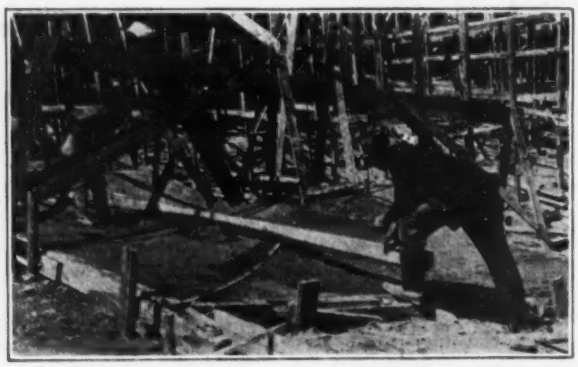
Dust-Bin for Shaking Out Empty Cement Bags

JOHN OWENS, foreman of the Englewood gravel-washing and concrete-mixing plant of the Miami Conservancy District, recently rigged up a simple bin with ventilating stack, in which empty cement bags can be shaken out without the raising of a cloud of irritating dust. The device is shown in the April *Miami Conservancy Bulletin* by the sketch reproduced herewith. It not only does away with dust, but it reclaims fully twice as much cement as shaking out the bags on the shed floor or in an open box, and allows the work to be done twice as fast. From 1500 bags shaken out, 11 bags of cement were reclaimed. The device consists of a box 6 ft. long, 3½ ft. wide, and 3 ft. deep, with a wooden air shaft running from the top of the box up through the roof of the cement shed. Three inches from the top of the box the two long sides flare out, as shown, at an angle of about 45°. The box has a lid narrower than the width of the box, so as to leave an open space about 2 in. wide between the long edges of the lid and the sides of the box, as shown. The empty cement sack is dropped mouth down through this 2-in. slot and shaken into the box. The effect of the ventilator is to prevent dust rising through the slot into the cement shed.



Suspended Angle Irons Form Screeds for Groined Floor

IN THE construction of the low-service reservoir for Dayton, Ohio, last year, the Danis-Hunt Co., contractor, used a special form of screed for the groined floor which is shown in the accompanying views. These



ANGLE IRONS HUNG FROM FRAME FORM SCREED

Other Articles in This Issue of Interest to Contractors:

Raising Allegheny River Bridge 13 Feet by Jacking ..... Page 850

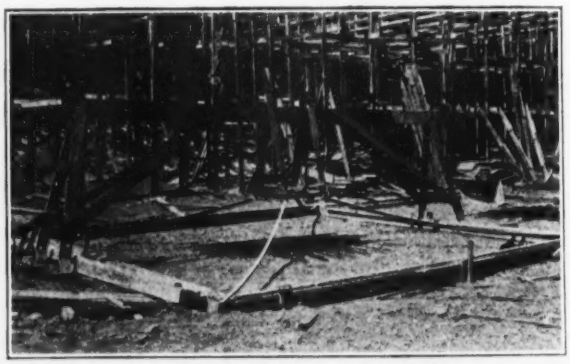
Engineering Societies Organize to Push Public Works Department ..... Page 855

Cost-Plus Contract Incentive to Close Management ..... Page 863

Cost of Highway Concrete Delivered Wet by Trucks ..... Page 870

Who Can Solve This Contractor's Problems? (Letter) ..... Page 884

floor groins were 20 ft. square at the bottom and 30 in. deep, resting on the ground over a reinforcing mat. A timber horse was placed over each groin location, and suspended therefrom was a wood frame carrying a steel frame to the size and shape of the groin. This steel frame was made of angle irons, with an upper square and four dependent corner angles bent to the curve of



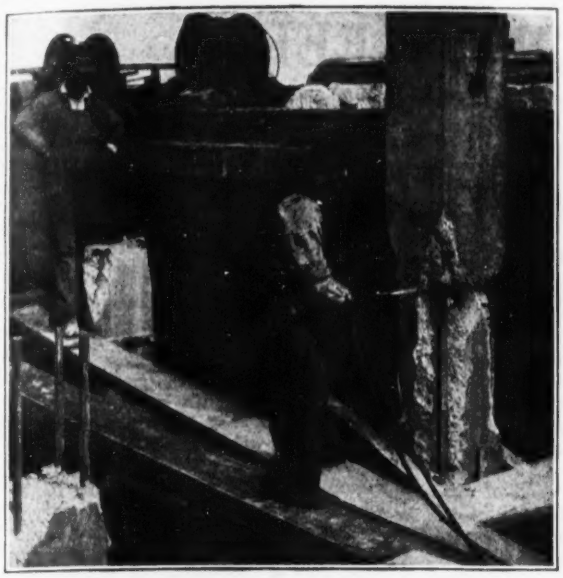
SCREEDING THE GROINED FLOOR TO THE ANGLE IRON

the groin, which angles rested at their outer ends on timbers laid to the proper dimensions on the ground.

Concrete was piled into the groin and screeded off against the angles, as shown in the second view. Just as soon as this concrete would hold its position the frame was lifted, and the small opening left by the angle, being pulled out, was filled in and troweled to surface. The work was under the general direction of H. C. Wight, superintendent of water of the City of Dayton.

Cutting Concrete Piles at Port Terminal

IN THE United States Army base at Charleston, S. C., precast concrete piles were used for a portion of the dock structure. These were cut to proper elevation, as shown in the accompanying view, by sledging off the surface concrete about 3 ft. above the cut-off level and cutting the rods with a gas torch. The concrete shaft

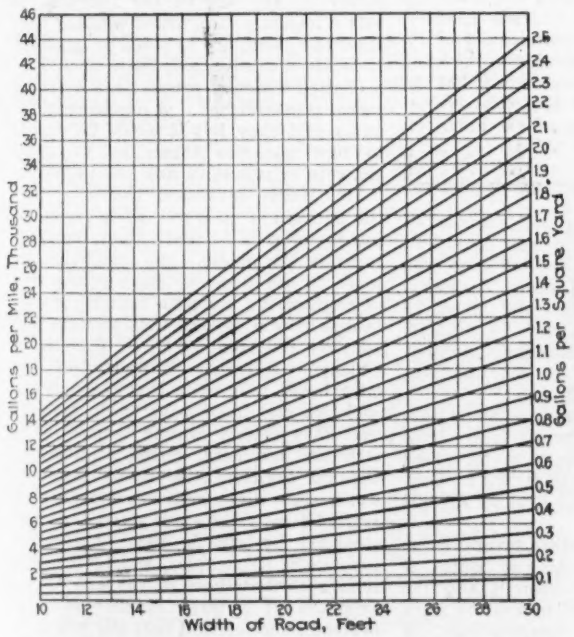


GAS TORCH CUTS RODS ABOVE CUT-OFF, AND PLUG AND FEATHER SEVERS SHAFT AT PROPER LEVEL

was then severed at the cut-off level with plug and feather, and the upper section pulled out by a derrick, leaving the projecting rods, as shown at the left of the view, for bonding purposes.

Number of Gallons of Road Oil Per Mile for Known Width and Rate

A HANDY chart for determining the number of gallons of road oil required to treat one mile of highway, when the width of the road and the number of gallons per square yard are known, is shown in the accompanying illustration. The chart was put out by the Union Oil Company.



GALLONS OF ROAD OIL REQUIRED PER MILE OF ROAD AT GIVEN WIDTH AND RATE

Knowing the width of the roadway, follow vertically upward until the line intersects the diagonal line of gallons per square yard as indicated at the right; then read the number of gallons per mile at the left. Thus, with a 20-ft. roadway and a rate of 1.8 gal. per square yard, 21,000 gal. would be required.

Grease Pump Is Useful to Dry Diaphragm Pumps in Cold Weather

A GREASE pump of about 1-in. diameter and 12-in. length has been used by William G. Cooper, contractor, on the Gravesend Ave. elevated line, Brooklyn, N. Y., for removing water from pumps of the diaphragm type each evening when they might be damaged by freezing during the night. By the sucking of the water into the pump and discharging it on the ground the water is removed quickly and with much greater ease than by the tipping up of the pump to dump it. The pointed nose of the grease pump can reach the smallest crevice and so gets all the water on top of the diaphragm.

Contractor's Canopy Need Not Be Ugly

SEVERAL times in *Engineering News-Record* there have been shown good-looking contractors' structures. The one here illustrated is another proof that these structures need not be eyesores. It was erected

EFFECTIVE CONTRACTOR'S CANOPY COMBINES GOOD APPEARANCE AND ADVERTISING VALUE

on Chestnut St., Philadelphia, by F. L. Hoover & Sons, contractors, at the new store for the A. H. Geuting Co., shoe dealers. The structure speaks for itself, and is a credit to the contractors who erected it.

NEWS OF THE WEEK

New York May 1, 1919

Engineers Want Topographic Maps of Country Completed

Expedition in the completion of the topographic maps of the country by the United States Geological Survey was urged Apr. 25, at Chicago, by the conference on a national department of public works. The conference by unanimous vote asked Engineering Council to present to the President and Congress facts as to the economic necessity of completing the maps at an early date. Already the National Service Committee has taken the matter up with the Secretary of the Interior who is in accord with the idea. He accepted the proposal to ask Congress for an increase in the pre-war estimate of $350,000 per year to $500,000. It is expected that the states will meet this amount with an equal sum.

F. W. De Wolf stated that only 42% of the country was mapped and at the present rate the completion would not be achieved within 80 years. A crisis has arisen in the topographic service because the last Congress cut the $425,000 asked for to $289,000. Fortunately the sundry appropriation bill did not pass and there is still time to amend it.

Meeting of United States Good Roads Association

The seventeenth national convention of the Good Roads Association, combined with the seventh United States Good Roads Show and the third annual convention of the Bankhead National Highway Association, was held at Mineral Wells, Tex., during the week of Apr. 19, and was well attended. The highway association elected the following officers: President, Senator John H. Bankhead, of Alabama; first vice-president, Gov. Charles H. Brough, of Arkansas; second vice-president, Gov. C. A. Larrazarole of New Mexico; third vice-president, R. M. Hubbard, of Texas, and director general, J. A. Rountree, of Birmingham, Ala. The Bankhead association elected the following officers: President T. S. Plowman; treasurer, L. G. Jones; general secretary, J. A. Rountree, and director-at-large, W. W. Heaton.

Competition for Illinois Road Contracts Not Active

Bids were scattered and bidders were comparatively few on the first two groups of sections of Illinois state-aid roads, the construction of which this year was announced. On the nine sections of the Dixie Highway, aggregating slightly over 42 miles of 16- and 18-ft. road, there were eight bidders, only one of which made prices on all nine sections. The largest number of bidders for any section was four, and on four sections only one bid each was submitted. On the Lincoln Highway, aggregating 20 sections and about 70 miles of road, there were 15 bidders. Four bids were the maximum number on any one section; on four sections there was only one bid each.

Itemized prices are not yet made public, but lump-sum prices ran from $17,500 to $29,000 per mile for these concrete roads 16 and 18 ft. wide. Generally, the bids ranged around $21,000 to $24,000 per mile.

Among the bidders were several large construction firms, such as Bates & Rogers, James O. Heyworth and the Foundation Co., which heretofore have not gone into road construction. A large number of constructors attended the lettings and watched closely the run of prices.

Employment

For the convenience of engineers returning from military life, and others, there are listed below agencies which may be helpful to those who are seeking employment:

Engineering Societies Employment Bureau; secretary, 29 West 39th St., New York City.

American Association of Engineers, 29 So. La Salle St., Chicago. Service to members only, but Army or Navy engineers in uniform who are eligible to certified membership may join without payment of entrance fees or dues while in uniform and for six months after discharge.

Engineers' Service Bureau, maintained by the Joint Council of Engineering Societies of San Francisco, Engineers' Club, 57 Post St., San Francisco. Only applications by mail or wire will be considered.

The Federal director of the United States Employment Service in New York State announces the receipt of a letter from J. P. Morgan & Co., in which $100,000 is offered for the purpose of continuing the work of the service up to July 1 of this year. The Professional and Special Section in New York will therefore be continued, but will be located at the main office, 469 Fifth Ave., New York City.

Engineering Council and Nonmember Societies

Chicago Conference Discusses Need for Federation of Engineering Organizations

Following the discussions on the proposed Federal Department of Public Works, the main topic set for the conference of engineering societies in Chicago last week, a session was devoted to the discussion of the relation of nonmember societies to Engineering Council. At times the subject was broadened to cover engineering society activities generally. The drift of the remarks was that a federation of engineering societies was needed, and that federation should come about through such amendment of the rules of Engineering Council that it could admit local societies. J. Parke Channing, chairman of the council, announced that such an amendment was pending, and both he and Dr. Ira N. Hollis, past chairman of the council, expressed the view that it would soon pass and receive the approval of the founder societies.

Veto Power Discussed

Mr. Channing, in opening the discussion, pointed out that even after the passage and approval by the four founder societies the amendment above referred to would still leave it in the power of any one of the founders to veto a measure. He asked whether that should be permitted to stand or whether, if locals are admitted, there should be a change whereby proportionate voting power is established. A number of delegates said they felt it would be unfair to new societies taken in, to allow the veto to repose in any one society.

Dr. Hollis expressed the view that the purpose of all worth-while engineering societies is to teach their members to serve the public. He urged that we learn to use what we have in the way of engineering societies rather than establish new ones, and that thought was heartily indorsed by C. F. Loweth, of Chicago. Gardiner Williams, of Detroit, while admitting that the national societies had done good work, believed that they should confine themselves to technical activities, letting Engineering Council organize the locals for civic work, since civic influence must be exercised locally. He advanced the view, seconded by others, that engineering practice is so complex and local conditions such that there is warrant for the existence of a large number of engineering societies, and that the new ones, so long as they had a good reason for being, would not harm the existing organizations. All should be tied to-

gether, however, by some coördinating agency.

Replying to a query whether the American Association of Engineers would consider affiliation with Engineering Council, C. E. Drayer, secretary of the association, said that he could not speak for his board. He did feel certain, though, that Engineering Council could neither absorb nor take the place of the association. He urged that the two organizations should not duplicate work.

The question of the attitude toward the union movement being raised, a number of speakers expressed the view that union methods were not consonant with professional ideals. One chief engineer of a railroad was cited who believed that his young men could get fair compensation only by organizing. Reference was also made to a prominent engineer who deplored the movement, but felt that no antagonism should be developed against the men who joined unions, so that when they have learned that the unions cannot satisfy their needs in a professional way they will not feel that the older societies have turned from them because of their earlier union affiliations.

Two-Way Flat-Slab Patent Invalid

Another flat-slab reinforced-concrete floor patent has been declared invalid in a district court. This one is the Sinks patent, U. S. No. 1,005,756, on a two-way construction. The decision was rendered Apr. 16, 1919, by Judge A. L. Sanborn in the United States District Court, northern district of Illinois, eastern division. Suit was brought by the Condron Co., present holders of the patent, against the Corrugated Bar Co. for infringement in the construction of buildings at Fort Wayne and Chicago.

Judge Sanborn concluded his decision as follows: "The patentee may have made a better flat-slab or shallow-beam construction than prior inventors, but the patent itself, apart from simplifying computation, simply proceeded along lines suggested by engineering skill. I think the patent is invalid and that the bill should be dismissed."

Pending a decision on this case in the United States Court of Appeals, the Condron Co. announces that it will make no royalty charges to its patent licensees, or to those who accept licenses from them for the use of the Sinks invention in flat-slab buildings erected or contracted for between Apr. 30, 1919, and the date of such decision, regardless of whether the decision, on appeal, sustains the Sinks patent or not. Under the Condron Company's agreement with the owners of the Norcross patent, which expired Apr. 29, 1919, all licenses granted by the Condron Co. for the Akme System have protected the company's patrons from claims of infringement of the Norcross as well as the Sinks patent.

Registration Law in Michigan Passes Legislature

Architects, Engineers and Surveyors Included Under Bill as Amended

The act for the registration of architects, engineers and surveyors has been passed by the Michigan legislature as an amended form of one of the alternate bills introduced into the legislature, and discussed in *Engineering News-Record* of Feb. 27, 1919, p. 423. It provides as follows:

All persons desiring to practice or to be be known as architects, engineers or surveyors, as principals or in responsible charge of work, must be registered by a board, to be appointed by the Governor and to consist of three architects and five engineers. All persons who have been engaged in practice as engineers or surveyors as principals or in responsible charge of work for a period of two years preceding the adoption of the act shall be registered without examination in the branch in which they show themselves to be qualified.

Registrants shall be designated as registered architects; or as registered engineers of such class as the work they may have done or for which they may be qualified may determine, particularly as of classes of less general qualification than that indicated by the title civil, mining, mechanical, electrical or chemical engineer; or as registered surveyors. No plat of the subdivision of land shall be received for record by any public official unless it has been prepared by a registered engineer or a registered surveyor and signed by him as such.

Persons desiring hereafter to begin practice as above shall pass an examination in the English language and in such other appropriate subjects as the board shall determine. Engineers and architects of recognized standing as specialists, resident in other states, shall be admitted to practice without examination, and engineers registered under laws of other states and countries providing equivalent requirements, and in good standing thereunder, shall be admitted to practice, provided that similar privileges are extended to the registrants under this act.

After the end of the construction season of 1919 no public work of an architectural or engineering character shall be undertaken by the state or any county, township, municipality or village thereof, the estimated completed cost of which shall exceed $2000, unless the plans therefor shall have been prepared by a registered architect or a registered engineer, and the work shall be supervised by a registered architect or registered engineer.

No time limit is set within which registration must take place for those now qualified to register under the act. No restriction is put upon the performance of architectural or engineering work for private parties by persons who do not call themselves architects or engineers. The act repeals the preëxisting act for the registration of architects, and provides that all registrants under that act shall be considered as registered under the new act.

The act requires an examination fee of $5 and a registration fee of $15 from those taking examinations, and a registration fee of $20 for those registered without examination, and a fee of $5 for renewal of certificates which are renewable, upon not less than 30 days' notice on Jan. 1, 1925, and on the first day of January every fifth year thereafter. The members of the board are appointed to hold office for eight years, one member to be appointed each year.

Executive Secretary for American Chamber of Commerce, London

Appointment of George P. Toby as executive secretary of the American Chamber of Commerce in London has been announced by its president, G. M. Cassatt. The membership of the London organization contains representatives in England of American manufacturing and exporting interests and also prominent British manufacturers, exporters and importers. It is equipped to handle inquiries expeditiously, and desires American business men to utilize the service.

Mr. Toby, the new executive secretary, has been long connected with banking and industrial corporations in this country and is well known as an investment banker. In this capacity he has made a careful study of the operation of American industries and public utilities. For over a year during the war he was connected with the Treasury Department at Washington on the preparation of plans for cooperation between the various Government departments and the business world, including studies of the markets for products, methods of distribution, etc. His visits to Europe in this connection and other extensive travels in Europe and Canada have given him a broad view of the field.

Consulting Engineers Honor French High Commissioner

The American Institute of Consulting Engineers gave a dinner in honor of M. de Billy, deputy high commissioner of France, on Apr. 24 in New York City.

The dinner was held immediately before the departure of M. de Billy. It was felt that the good will of the engineering profession should be evidenced, as the commissioner himself is an engineer. In speaking of his experiences in this country, M. de Billy dwelt upon the aid that American engineers had extended to the commission in the work it has been doing during the war.

The following guests were present: M. de Billy, deputy high commissioner, French Republic; Controleur H. Johannet, Colonel Dulauroy, Colonel Duvaux, Captain Vaneufville, Lieutenant Mittaine, all of the French mission; S. M. Felton, formerly director general of military railways, United States Army;

Consul General Romolo Tritoni of Italy; Consul General Pierre Mali of Belgium; E. G. Spilsbury, M.E.; Nelson P. Lewis, C.E.

Civil Service Examinations

New York.—Junior assistant engineer, State Engineer and Highway Department, $1200-$1440 per year, May 24. Apply to State Civil Service Commission, Albany, N. Y. File applications before May 24.

New York.—Bridge designer, Public Service Commission, First District, $1501 to $2100 per year. Apply to State Civil Service Commission, Albany, N. Y. File applications before May 24.

Philippines.—Wireless engineer, Bureau of Posts, Philippine Government, $3000 per year, June 10. Apply for form B. I. A. 2, to be filed before June 10, filled in by medical officer in the service of the United States.

Tennessee.—Assistant highway engineer, $1800 to $2100 per year, May 7, at Nashville. File applications as soon as possible.

For United States Civil Service examinations listed below, apply to United States Civil Service Commission, Washington, D. C., or to any local office of the commission, for form 1312.

United States.—Expert patent investigator, $1800 to $2400 per year, and technical patent expert, $2400 to $3600 per year, May 20.

United States.—Highway bridge engineer, $1800 to $2100 per year, junior highway bridge engineer, $1200 to $1600 per year, Bureau of Public Roads and Rural Engineering, May 21. File applications in time to arrange for examination at place selected by applicant.

United States.—Engineer in forest products, $1860-$3000 per year; assistant engineer in forest products, $1200-$1800 per year, Forest Products Laboratory, Madison, Wis., May 27. File applications before May 27.

United States.—Chief of road survey party, $1800 to $2100 per year, transitman for road surveys, $1200 to $1800 per year, highway draftsman, $1200 to $1800 per year, Bureau of Public Roads and Rural Engineering, May 29. File applications before May 29.

United States.—Scientific assistant in public health work, Public Health Service, $1500-$2500 per year, June 3. Apply for form 2118, to be filed before June 3.

United States.—Senior engineer and senior architect, Interstate Commerce Commission, $1800-$2700 per year, June 10. File applications before June 10.

United States.—Assistant material engineer, Bureau of Construction and Repair, from $4.48 to $6.40 and upwards per diem. No date specified. Applications should be filed without delay.

United States.—Junior recreational engineer, Forest Service, Denver, Colo., $1800 to $2400 per year, May 6. Apply for Form 2118.

United States.—Statistician, Department of Interior, $1800 per year, May 13. Apply for Form 2118.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

NATIONAL FIRE PROTECTION ASSOCIATION; 87 Milk St., Boston, Mass.; May 6-8, Ottawa, Can.

AMERICAN ASSOCIATION OF ENGINEERS, 29 S. LaSalle St., Chicago; May 12-13, Chicago.

NATIONAL CONFERENCE ON CITY PLANNING; 19 Congress St., Boston; May 26-28, Niagara Falls and Buffalo.

AMERICAN WATER-WORKS ASSOCIATION; 47 State St., Troy, N. Y.; June 9-13, Buffalo, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS; 29 W. 39th St., New York; June 17-20, St. Paul-Minneapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS; University of Pennsylvania, Philadelphia; June 24-27, Atlantic City, N. J.

AMERICAN CONCRETE INSTITUTE; 6 Beacon St., Boston; June 27-28, Atlantic City, N. J.

The San Francisco Association of Members of the American Society of Civil Engineers was addressed Apr. 15 by W. Lewis Clark, an engineer of the California Highway Commission, who spoke on experience in that state in highway construction. Mr. Clark spoke for A. B. Fletcher, chief engineer of the commission. Among the subjects discussed were engineers' licensing laws, the trend toward union organization of draftsmen and engineers, the Development Committee program, and means of strengthening the influence of the parent society.

The Engineers' Society of Milwaukee held its regular monthly meeting Apr. 29 under the auspices of the Milwaukee section of the American Institute of Electrical Engineers. The meeting was addressed by A. A. Oswald, of the Western Electric Co., who read an illustrated paper on "Wireless Telephony and Telegraphy in War."

The Montana Society of Engineers voted to make eligible for membership all members of the national engineering societies, without restriction to any single branch of engineering. This action, in the form of an amendment to the constitution of the society, was taken at the annual meeting held in Great Falls Apr. 11-12. The following officers were elected for the coming year: President, Samuel Barker, Jr., Butte; vice-presidents, Charles A. Lemmon, Anaconda, and George T. McGee, Helena; secretary and librarian, Clinton H. Moore, Butte.

The Pittsburgh Chapter of the **American Association of Engineers** will hold an open meeting for railroad technical engineers May 3. Among the speakers will be D. A. Tomlinson, assistant secretary of the national association.

The Engineers' Club of Minneapolis was addressed Apr. 21 by B. S. Moodey, of the Minneapolis Steel & Machinery Co., who spoke on the heat treatment of steel.

The Engineers' Club of Trenton was addressed Apr. 24 by J. F. Lincoln vice-president of the Lincoln Electric Co., Cleveland, who spoke on "Electric Arc Welding as Applied to Present-Day Commercial Manufacturing and Repairs."

The Oregon Society of Engineers was addressed Apr. 25 by G. C. Wells, who spoke on "Engineering and Exploration Experiences on the Malay Peninsula."

The New York Chapter of the American Association of Engineers held a meeting Apr. 23, at which Robert M. MacBride spoke on his experiences while in Europe with the party of journalists who accompanied President Wilson in the inspection of the devastated districts. The next meeting of the chapter will be held May 14.

PERSONAL NOTES

H. ELTINGE BREED, who has resigned as first deputy commissioner, New York State Highway Department, as mentioned in *Engineering News-Record* of Apr. 24, 1919, p. 840, has opened offices in New York City at 507 Fifth Ave., for the private practice of engineering, specializing in highway work and organization. Mr. Breed was graduated from Colgate University in 1900 and soon afterward entered the service of the Newport News Shipbuilding & Dry Dock Co. A year later he entered the department of the State Engineer and Surveyor of New York State, passing through various civil-service grades to the rank of assistant engineer. In 1911 he was with the State Highway Commission engaged in design work, and in the following year he had charge of the Coleman du Pont road in Delaware as assistant chief engineer. After visiting Europe to study

highway conditions he engaged in private practice until 1915, when he was appointed first deputy commissioner of the New York State Highway Department. He served in that capacity until his recent resignation.

COL. JAMES SCRUGHAM, who resigned the position of state engineer of Nevada, to enter Government service, has been reappointed to his former position by Governor Boyle. SEYMOUR CASE, who filled the position of state engineer in Colonel Scrugham's absence, has been appointed assistant state engineer.

PROF. CHARLES A. HOLDEN, who for the past year has served as acting director of the Thayer School of Civil Engineering, Dartmouth College, has been appointed director. He was born in 1872 and was graduated from Dartmouth College in 1895, and six years later from the Thayer School of Civil Engineering. He afterward entered the engineering department of the Boston & Albany R.R. In 1900 he became instructor of civil engineering in the Thayer School and was later appointed assistant professor of civil engineering and assistant professor of mathematics. From 1900 to 1904 he acted as resident hydrographer for the United States Geological Survey, at Hanover, N. H.

CAPT. R. S. MOORE, Engineers, U. S. A., who was with the 209th Engineers when demobilized at Camp Sheridan, Montgomery, Ala., has entered the service of the Shipyard Plants Division, Emergency Fleet Corporation, Gulf district, with headquarters at Houston, Tex.

H. G. COUTTS, general superintendent of the housing division, United States Shipping Board, Emergency Fleet Corporation, has resigned to become associated with the Free-Luce Land & Building Co., Cleveland.

HERMAN ROEMER, Baltimore, who has recently been engaged in Government work, has been appointed superintendent of the paving division, highway engineer's department of that city.

W. C. HARTMAN, Construction Division, U. S. A., has received his discharge from the service and has returned to his former work as designer of reinforced-concrete structures, Widmer Engineering Co., St. Louis.

A. L. DABNEY, consulting engineer, Memphis, Tenn., who has been engaged in Government work at Muscle Shoals, Alabama, has returned to his office in Memphis to resume private practice. In 1917 he was commissioned as a major of engineers and attended an officers' training camp, later resigning his commission, being physically disqualified. He was then stationed at the Air Nitrates Plant No. 2, Muscle Shoals, for more than a year, in charge of the construction of water-works, sewers and drainage, and later in charge of operation.

ERNEST G. EAGLESON, consulting engineer, Boise, Idaho, has been elected mayor of that city. He is a graduate of Nebraska University and for many years has been engaged in irrigation and other engineering work in the West. In 1911 he was elected city engineer of Boise and has more recently been engaged in private practice.

CAPT. E. V. GUYTHER, Construction Division, U. S. A., who recently received his discharge from the service, has returned to his former position in charge of municipal engineering work with the Widmer Engineering Co., St. Louis.

JOHN F. VAUGHAN has resigned as district manager, Emergency Fleet Corporation, New England district, and has resumed his engineering practice at 185 Devonshire St., Boston, which has been in charge of his principal assistant, E. A. EKERN, during his service with the Government.

NICHOLAS S. HILL, JR., and S. F. FERGUSON, consulting engineers, announce the removal of their offices and laboratory from 100 William St. to 112 E. 19th St., New York City.

COL. JAMES B. CAVANAUGH, Corps of Engineers, U. S. A., has been appointed United States district engineer of the Nashville, Chattanooga and Florence, Ala., districts, with headquarters at Nashville.

R. C. STARR, superintendent of construction, Stone & Webster Corporation, with headquarters in Seattle, has resigned to become construction engineer, San Joaquin Light & Power Corporation, at Fresno, Calif. Mr. Starr has charge of work on the hydro-electric project now being rushed to meet the demand for additional power. Previous to his association with Stone & Webster he had charge of raising the height of three dams at Huntington Lake in Southern California for the Pacific Light & Power Company.

CAPT. GEORGE R. CAMPBELL, Engineers, U. S. A., has received his discharge from the service and has been appointed United States cadastral engineer, Department of the Interior, with headquarters at Olympia, Wash.

EARL WHEELER, O. A. MECHLIN and FRANK RHEA have become associated under the firm name of WHEELER, MECHLIN & RHEA, advisory and purchasing engineers, with offices in the West St. Building, New York City. The work of the firm will consist of furnishing service to foreign and domestic clients, purchasing machinery and engineering materials in the United States to be used to construct, maintain and operate property.

CAPT. EDWARD M. BURD, Coast Artillery, U. S. A., who recently received his discharge from the service, has become associated with the Blaw-Knox Co. of Pittsburgh as designer and salesman in transmission tower and structural work.

PROF. JAMES E. SMITH, Department of Civil Engineering, University of Illinois, has been elected mayor of Urbana. He has been a member of the city council for four years.

E. L. WAGNER, formerly of the firm of ROBINSON & WAGNER, sewage-disposal engineers, New York City, has opened an office at 320 Fifth Ave., for the practice of sanitary engineering.

LEIGH HUNT, consulting engineer, Kansas City, Mo., announces the formation of the Leigh Hunt Co., successor to the Hunt Engineering Co. The new company will engage in general engineering and contracting.

IRA G. HEDRICK and W. W. HUFF have become associated under the firm name of HEDRICK & HUFF, consulting engineers, Kansas City, Mo.

J. C. RALSTON, formerly city engineer of Spokane, Wash., has been appointed consulting engineer of the Columbia Basin Commission.

PHILIP PETRI, district engineer, Baltimore & Ohio R.R. Lines East, with headquarters in Pittsburgh, has been appointed division engineer, with headquarters at Cumberland, Md.

OBITUARY

CHARLES H. JACOBI, assistant engineer, Division of Capital Expenditures, United States Railroad Administration, died in Salt Lake City Apr. 20. He was born in 1883 and was employed for a number of years as assistant engineer, Lehigh Valley R.R., and more recently as construction engineer, Westinghouse Church Kerr & Co. He entered the service of the United States Railroad Administration in July, 1918.

S. SANNE-JACOBSEN, of the firm of Gannestad & Jacobsen, consulting engineers, Pittsburgh, died in Beaver, Penn., Apr. 11. He was a graduate of the technical school of Horten, Norway, and had been engaged in engineering work in the Pittsburgh district for the past 25 years.

Manufacturers' Association Annual Convention in New York

The National Association of Manufacturers has announced its annual convention, to be held at the Waldorf-Astoria Hotel, New York City, from May 10 to 21, inclusive. Topics to be discussed are: Governmental ownership of railroads, Government supervision and stabilizing of trade prices, Federal revenue and tax legislation, employment relations, employers' duty to provide jobs for sailors and soldiers, approaching revision of the patent laws, the industrial legislative outlook, and vocational training.

Among the speakers will be Walker D. Hines, director general of railroads; Daniel Willard, president of the Baltimore & Ohio R.R.; Prof. William Starr Myers, Princeton University; Frank A. Halsey, commissioner of the American Institute of Weights and Measures, and Edward J. Prindle, member of the committee on patent law revision of the Council of National Defense.

Many committee reports will be made; among them will be one by the committee on readjustment after the war, which will make recommendations, having made an exhaustive survey of the present situation.

Motor-Truck Company To Make Large Increase in Plant

Expenditures involving $37,398,000 in new plant will be made during 1919 by the General Motors Corporation, as outlined by W. C. Durant, president and general manager. The additions will be made in office and sales buildings and new equipment in Detroit, Flint, Pontiac, Lansing, Saginaw, Mich., Toledo, Ohio, St. Louis, Mo., Janesville, Wis., Bristol, Conn., and Muncie, Ind. About $12,650,000 will be spent in Detroit, including $5,000,000 for a fifteen-story general office building, with a four-story research laboratory in the rear. The next largest expenditure will be at Flint, where $6,715,000 will be expended. In the latter appropriation a thousand homes for employees, with water mains, sewer systems, paved streets, etc., are provided for.

Unemployment Decreases, Says Federal Employment Service

Employment conditions throughout the United States are steadily improving, according to reports received by the United States Employment Service, from 3417 representative concerns in 58 cities. While there is still a surplus in many cities, some report a shortage of skilled and unskilled labor.

Among the cities replying, 27 report a surplus of labor of 59,957 as compared with 73,576 during the previous week. Six of the cities show a combined shortage of 3600 skilled and unskilled laborers. The other 15 report an approximate equality of supply and demand.

The labor surplus has disappeared in New York, and conditions in the New England States show a marked improvement. Several cities which last week reported heavy surpluses reported this week an apparent equality of supply and demand. Of the six cities reporting a shortage of labor all are in the South except Seattle. They are Louisville, Ky., Wilmington, N. C., Charleston and Columbia, S. C., and Memphis, Tenn.

Shoveling Attachment for Road Rollers and Tractors

An attachment for shoveling earth, which may be used upon steam, gas or electric tractors and upon steam rollers, is shown in the accompanying photographs of work at Myers Park, Charlotte, N. C. The device was invented by C. H. Wolfe, of Charlotte, and has been used by the Mecklenburg

CYCLE OF OPERATION OF SHOVEL ATTACHMENT

County government, on road work. With the shovel removed, the attachment makes a useful portable derrick.

Operating in practically a horizontal position, it is said to have proved particularly adaptable to road work in skimming off shallow cutting. The derrick portion allows the shovel to swing through an angle of 180° for dumping, so that the wagons do not have to be placed accurately. It can handle old macadam, gravel, shale, crushed stone, coal, sand and snow. Only a few minutes are required to remove the shovel in order to use the attachment as a derrick. The method of operation is readily seen from the three photographs.

The shovel-pan is 7 ft. wide, 4½ ft. from cutting edge to back, and 1 ft. deep. When level full it holds about 30 cu.ft. and will handle 1½ cu.yd. when heaped. In the two machines which have been manufactured and are in use, the shovel is made the same width out to out as the traction engines to which they are attached, so that the wheels of the engine are always running upon a smooth surface. The weight of the entire outfit, including engine, is 22,000 lb., and it can be operated in all locations and over soil conditions which will support a traction engine of this load.

Under favorable conditions, the machine is reported to have loaded a maximum of 680 loads in a 10-hour day, and the average performance is said to be 450 loads for this period. It is operated by one man who handles all the levers and also fires the engine.

It is understood that Mr. Wolfe holds a patent on the attachment, which is to be manufactured by the Moffatt Machinery Manufacturing Co., of Charlotte, N. C.

BUSINESS NOTES

The Ferro-Concrete Products Co. is the name of a new concern organized by A. M. Fisher, formerly with the Concrete Steel Products Co. of Chicago, and recently discharged as captain from the Fifth Division, American Expeditionary Forces. The offices of the company will be in the Harris Trust Co. Building, Chicago, where it will represent the Witherow Steel Co. and the Electric Welding Co., both of Pittsburgh.

The Chain Belt Co., of Milwaukee, Wis., announces that the J. J. Wernette Engineering Co., of Grand Rapids, Mich., will handle the former company's "Rex" line of concrete mixers and pavers.

The Sullivan Machinery Co. announces the organization of a foreign-trade department, with S. W. Copeland, formerly attached to the St. Louis office, as manager, with headquarters in Chicago. The company has branch offices in London, Salisbury House; Paris, 18 Ave. Parmentier; Santiago, Chili, Casilla No. 27, and at Sydney, N. S. W., Chambers, Martin Place. Agencies are established in various other foreign countries.

The Chicago Pneumatic Tool Co., Chicago, Ill., announces the appointment of T. J. Hudson as acting manager of the pneumatic tool sales division. He succeeds S. H. Waldron, who will return to Minneapolis, Minn., as district manager of sales for that territory. The company also announces the election of Allan E. Goodhue as managing director of its English subsidiary, the Consolidated Pneumatic Tool Co., Ltd., with offices at 170 Piccadilly, Lon-

don, and with plant at Fraserburgh, Scotland. He will also have charge of European sales for the Chicago Pneumatic Tool Co. Mr. Goodhue was for a number of years connected with the sales department of the Midvale Steel Co. and the Midvale Steel and Ordnance Co. of Philadelphia, Chicago and Boston, leaving to enter the Government service in March, 1918, as manager of the steel and raw material section, reduction division, of the Emergency Fleet Corporation, which position he held until Jan. 1, 1919.

The Daly Meter Co. will move its main office and works from Boston, Mass., to Cleveland, Ohio, effective May 1. The Boston office will be retained with H. D. Fisher as manager, to handle sales and engineering service in the New England district. For the present the New York and Philadelphia districts will also be covered from the Boston office. All other districts will be covered from Cleveland.

TRADE PUBLICATIONS

The Lakewood Engineering Co., of Cleveland, Ohio, has issued a new bulletin, No. 29-A, describing Lakewood road-construction plants. The first half of the bulletin describes the methods employed in the construction of roads in large contracts, the remainder is devoted to a description of the equipment used.

The Yale & Towne Manufacturing Co., of 9 E. 40th St., New York City, has issued a semi-centennial souvenir in the form of a 76-page booklet, containing a history of the corporation and industrial biographies of various men prominent in the company. The booklet is 5½ x 8 in. and is illustrated.

"Heavy Duty Oil Engines" is the title of bulletin O. E. 20 of the Pittsburgh Filter & Engineering Co., Pittsburgh, Penn. The booklet contains eighteen 6½ x 9-in. pages and deals with the subject of large internal-combustion engines.

"Banking Service for Foreign Trade" and "Trading With China" are the Titles of two pamphlets issued by the Guaranty Trust Co., of New York. The former describes banking connections in foreign countries and the various methods of exchange. The latter is a general booklet dealing particularly with China, and describes the methods found successful in dealing with the Chinese.

The Solar Metal Products Co., Inc., of Columbus, announces the following changes in its organization: G. R. Le Sauvage, who was elected president Jan. 2, 1919, has assumed the duties of general manager, succeeding H. R. Gogay, formerly vice-president, treasurer and general manager, who has resigned; E. C. Camp has been elected assistant treasurer, and assistant to the president, and continues his work as sales manager.

"Highways and Railways for the Defense of Our Nation" is the subject of a 6 x 9-in. 20-page booklet just issued by Sauerman Bros., manufacturers of cableway excavators, car scrapers, etc., Monadnock Block, Chicago, Ill. This booklet deals with a general plan of defense for the United States and lays stress upon the necessity of good highways in time of war. It contains illustrations of various methods of defense, and of heavy artillery apparatus.

The Wallace & Tiernan Co., Inc., 349 Broadway, New York City, has just issued an 8½ x 11-in., 64-page pamphlet entitled "Chlorine Control Apparatus." The book is illustrated with half tones and line cuts showing apparatus, layouts and charts pertaining to the control of chlorination.

Construction Costs Carry On

Changes for Most Part Unimportant—Steel Deadlock Continues—Better Feeling Throughout Country Than Reported Last Month

By Alden W. Welch

In considering present prices of construction materials, one must not see only his little vicinity to the exclusion of the rest of the world. Prices are higher everywhere. They have advanced in sections where the influence of the war was not directly felt. Inflation is general. So much money and its equivalent in the form of bonds has been issued that its buying power has depreciated.

There is one safe highway, but it can be traveled by means of only one conveyance—confidence. What prices were last month, they are the same today. Here and there one material or another has cheapened, just as here and there other materials have advanced.

A general decline is almost as inconceivable as a general rise—though the latter is possible. This is a period when, as never before, the much criticised British slogan, "Business as usual," applies. And by "business as usual" not present business is meant, but the lively business that the needs of the country warrant.

It Is Time To Start Building—Prices Cannot Drop

Probably never in the history of the world was the housing situation more acute. In this, the richest nation, there are insufficient dwellings. Houses are being sold over the heads of people who have nowhere else to go. This serious tension is not being relieved by private initiative. It is a crisis beyond which is some unknown climax, which will be reached unless something is done. The thing to do is to build.

Everybody ought to know that prices cannot return to the pre-war level. Is there any man who will voluntarily submit to a reduction of his income? Organized labor is receiving more than ever it did, but it is demanding still more. The establishment maintained by a salary would collapse if the salary were appreciably reduced. And the same thing is true with those who receive dividends. Pre-war prices should be forgotten, because the world is upon the threshold of a new era.

Inasmuch as steel is the chief material element in the foundation of industry, any uncertainty regarding the future price of this product renders the entire structure uncertain. Last month the only general price movement was in steel, which declined $7 a ton. The new schedule was fixed by the Government's Industrial Board and the manufacturers, in joint session. It was expected that the new prices would be accepted by Government and public alike, but the Railroad Administration refused to do business under these revisions. A month has been consumed in controversy, which ought to be settled forthwith. Until it is settled, the national construction program will remain "in the air."

The latest word at this writing is from George N. Peek, chairman of the Industrial Board. In a letter to Director General Hines he says:

"The prices arrived at were the lowest which the members of the board believed that they could recommend and which would at the same time permit the producers to maintain the existing scale of wages and preserve the average independent producer. . . . If, however, you have any facts, figures or information showing that, on any ground whatsoever, the price recommended was too high, we shall be glad to approach the representatives of the steel producers again, and attempt to secure a modification of their offer in accordance therewith."

It would seem that the logical step would be for the Railroad Administration, the Industrial Board and the producers to get together and remain in session until a satisfactory agreement was reached. The existing uncertainty in the steel situation has a sinister influence upon the whole construction field.

Throughout the Country

New York—There are few price changes to report. The most important is in cement, which is now $2.30 net in cargo lots, alongside dock to contractors, against $2.45 net last month. As elsewhere, the charge for sacks has been reduced to 60c. per barrel instead of $1. The fluctuations on all the materials in the New York market are clearly shown

in the three-page price section that follows this article.

An encouraging sign is the two large building projects about to be got under way at Times Square. In this one neighborhood, it is reported, ground will be broken this week for a 20-story office building to cost $2,500,000, and soon after for a million-dollar structure to house two educational and civic-improvement organizations. The latter building is to be ready for occupancy by January.

Probably nowhere else than in New York is the incentive to build greater. This is not only because of high rents and the fact that the demand for apartments continually increases, but extensive transit improvements that have been under way for a number of years have just been completed, thus giving access to large, open areas, now made convenient to the several business districts of the metropolis. In past times apartment houses were erected largely in the hope that they would eventually be filled. Today they may be built on the certainty of immediate occupation. Just as soon as it is recognized that prices higher than in 1914 are a healthy reflection of the prosperity of the country, capital will become active. It is a very difficult task, however, to convince capital of the fact that today's prices will be tomorrow's.

Chicago—The building situation is improving slowly, as indicated by the accompanying tabulation of permits, which compares the activities of the middle weeks of March and April. From Apr. 5 to Apr. 19 permits issued numbered 127 more than in the corresponding period of March, the improvement amounting to 70 per cent.

COMPARISON OF BUILDING PERMITS ISSUED IN CHICAGO IN MIDDLE TWO WEEKS OF MARCH AND APRIL

	Residences	Stores	Factories	Warehouses	Miscellaneous Buildings	Total
March 15	73	4	4	2	4	87
March 22	80	1	3	5	4	93
April 12	160	5	3	2	18	188
April 19	93	2	5	4	17	121

	No. Over $100,000	No. Over $50,000	No. Over $5000	No. Less Than $5000	Total Amount
March 15	None	2	19	28	$521,000
March 22	2	3	19	34	1,370,500
April 12	6	2	54	57	2,509,950
April 19	3	1	41	48	1,261,400

As the greater portion of the present building activity is in small homes, the materials feeling the greatest effects are brick, lumber, etc. Other materials in excellent demand are paints, oils, turpentine and glass, owing to the large amount of building-repair work now going forward.

Boston—Generally the prices are much the same as last month. The principal interest appears to be in lumber. In one week 4,000,000 ft. b.m. were used to construct reviewing stands. This special demand exhausted the stocks of the smaller yards, with a consequent brisk demand, but the situation is only temporary. Two lumber dealers, the Blanchard Lumber Co. and Waldo Bros., profess to see a slight change in favor of opening up work, asserting that conditions in the smaller towns justify their optimism. In Boston, however, there is very little construction, though more than $50,000,000 worth is estimated to be on the drafting board.

Baltimore—Optimism appears to prevail, it being predicted that, beginning July 1, the building trades will be busier than in many years. As Baltimore prices are not included in the monthly price section of *Engineering News-Record*, it may be stated that common brick is quoted at $18 delivered; front-face brick averages $24; sand 50c. and 60c., respectively, for two grades, at railway loading points; gravel, two grades, $1.10 and $1.30 per ton; crushed stone, $1.25 for 2½-in.; fabricated steel, $115 a ton; lumber, common, including pine, fir, hemlock and spruce, $45 to $47.50 delivered from local yards in city; heavier timber, up to $55 delivered.

St. Paul—The most notable feature was the drop in cement, from $2.40 to $2.20 net. Natural cement followed from $1.63 to $1.55, as did also hydrated and lump lime. Lumber is at present the same as last month, but an increase is expected in fir, the principal timber in this market. At a meeting of the West Coast Lumber Manufacturers' Association, Apr. 6 in Tacoma, Wash., costs were analyzed, with the result that there was an apparent loss of $2.80 per 1000 ft. The revised price of fir in St. Paul will likely approach closely the present price of pine in this territory. Sandstone paving blocks are out of the market, owing largely to the shutdown and dismantling, during the war, of the plant at Sandstone, Minn. Bids were recently requested by the City of St. Paul but no response was received from Wisconsin quarries. Building activities are slow, but the general feeling is much more optimistic. Engineers and architects are doing considerably more estimating than a month ago.

Detroit—Several large buildings are planned or are under construction. These include banks, office buildings and mercantile blocks. Several large industrial works are contemplated. For some of these the sites are being purchased and the preliminary arrangements are being made.

St. Louis—Prices carry on in St. Louis. The reductions in triangle mesh and nails are a belated reflection of last month's general decline in steel. The lower price of brick is apparently a further effort to stimulate construction. The increase in the price of 3½-in. wood block is not important, being merely an attempt to establish a current price. It would probably fall if large orders were in prospect. Grading and paving work have started, as have also some sewer work and a small amount of home building. The general situation, however, is what is was in March.

Kansas City—Paving work has just opened up in a large way. Many important contracts are under way and others have yet to be awarded. The Real Estate Board, backed by other organizations, has inaugurated a "Build-a-Home" campaign. Large yellow-pine industries announce a contemplated increase within the next two weeks of from 50c. to $1 per 1000 ft. They report that the supply from the Southern fields is only 60% of normal, while the capacity for output is but 70% efficient. It is asserted that labor, though sufficient, is less efficient than it was before the war. Foreign demand for yellow pine has increased incalculably since the armistice was signed, and shipping facilities have improved to such an extent that heavy export is possible. Previous to the war, lumber shipped to Europe had to be of certain grades and sawed according to specifications. Now, the yellow-pine men say, Europe wants just lumber, and it does not ask the price, taking all sizes and grades standard in this country. Portland cement has been reduced from $2.30 to $2.26 net in carload lots, Eastern lime from $22.80 to $22 per ton. Fir lumber has been increased $2 per thousand. Dynamite is also less in cost.

San Francisco—Price changes in this city are for the most part reflections of the general decline in steel last month. The reduction in the price of Douglas fir is most interesting, in view of the threatened increase elsewhere, and is said to be an effort to stimulate construction.

General Situation

On the whole, the industrial voice of the country contains a cheerful note. It is frankly admitted that there is not enough construction work under way, but the present quiet seems to be a natural calm immediately preceding unusual activity. Not only is there a vast amount of private building which must be done, but there is an almost incalculable public program that will have to be carried out. Consider just one item—school houses. The Department of Labor estimates that contracts for nearly a thousand public school houses aggregating $100,000,000 have been held up because of the war. Educational demands are superior to material prices, and just as these schools will have to be built, so will sewerage plants and water-works, public improvements generally, and an unnumbered host of residence buildings.